ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XLVII. No. 14.

TABLE OF CONTENTS:

(20 pages; no insct.)

ENGINEERING NEWS OF THE WEEK.....265, 273
Concrete Mixing and Depositing Machines for Street Work (illustrated)..... 266
The Present Organization of the United States Coast and Geodetic Survey 266
A 25-Ton Hot-Metal Mixer (illustrated)..... 267
Proposed New Gas Plants in Paris..... 267
Combination Concrete and Steel Railway Ties (illustrated) 268
A European Tandem-Compound Engine Using Superheated Steam (illustrated) 268
Power Plants of the St. Louis Transit Co. I. (illustrated)..... 269
An Estimate for Rebuilding the Austin Dam (illustrated)..... 272
A New Form of Concrete-Steel Column Footing (illustrated)..... 273
Flexible Metallic Hose (illustrated) 277
The Industrial Uses of Alcohol in Germany..... 277
Changes in the Levels of the Great Lakes (illustrated).. 278
Notes from the Engineering Schools..... 278
Typhoid Fever Due to Alleged Improper Mechanical Filtration at Conneaut, O..... 278
Book Reviews 278
Committee Reports at the Convention of the Railway Engineering and Maintenance-of-Way Association (illustrated)..... 279
The Non-Continuous Swing-Bridge: Two Existing Structures of this Type (illustrated)..... 284
EDITORIAL NOTES..... 274
The Financial Failure of the Massena Water Power Plant—No Appropriation for Erie Canal Enlargement—A Deep Waterway from the Lakes to the Hudson—Municipal Bath Houses in the United States—More Car Coupling Legislation—Electric Motors for Trains Running Through the Park Ave. Tunnel—Admiral Bowles in Opposition to the Shafroth Bill.
EDITORIAL:
Sewage Purification and Water Pollution in the United States..... 275
LETTERS TO THE EDITOR..... 276
Mortar for Use in Masonry Exposed to Heat—The Duluth Ferry Bridge—Requirements in Letting Government Contracts—Eliminating the Turnout in Computing Track Connections (illustrated)—Priming Centrifugal Pumps.

THE STEAMER "SHAWMUT," of the Boston Steamship Co., was launched on Dec. 21 last from the yard of the Maryland Steel Co., at Sparrow's Point, Md., and has just completed her official trial trip. The "Shawmut" is a freight steamer, 505 ft. long over all, 488 ft. between perpendiculars, 58 ft. molded beam, 40 ft. molded depth. There are six water-tight bulkheads and a complete water bottom divided fore-and-aft into six tanks; in all the tanks provided have a capacity of 2,800 tons. The machinery includes two vertical triple-expansion engines, 22½, 39 and 63 ins. diameter of cylinders, with 45-in. stroke; these are designed to develop 4,000 HP. at 200 lbs. steam pressure. Steam is supplied by four single-ended Scotch boilers, 15 ft. 6 ins. diameter by 10 ft. 9 ins. long, with corrugated furnaces and the Howden system of forced draft. The vessel is expected to carry 10,000 tons of cargo and 1,200 tons of coal on a mean draft of 27.4 ft. On her trial trip the "Shawmut" attained a speed of nearly 15 knots, and she is expected to make a speed of 12½ knots loaded.

GROUND FOR A JOINT OUTLET SEWER for Elizabeth, Irvington, Vailsburg, a small part of Newark, South and West Orange, Millburn, Summit and Morristown, N. J., was formally broken on March 27, at Bayway, Elizabeth. Addresses were made by Mr. Robt. S. Sinclair, of South Orange, Chairman of the Joint Sewerage Committee; by Mr. Alex. Potter, Assoc. M. Am. Soc. C. E., of 150 Nassau St., New York, Consulting Engineer for the work. The contractor for the first, or lower section, work on which has just been started, is Mr. T. J. Shea, of Quincy, Ill. Bids for the second section will be received on May 8, and for the remaining sections on June 15. The total length as planned is 22.6 miles. This includes ½ mile 72-in., ¼ mile 66-in., 6 miles 42-in., 3 miles 38-in., 2 miles 33-in., 5 miles 24-in., and 6 miles of smaller sewers. The Morristown extension, recently decided on, includes a tunnel two miles long under the city of Summit, and 10 miles of 24-in. sewer additional to the foregoing. Legislation has just been secured by Morristown to enable it to connect with and share in the joint outlet sewer. A unique feature of the trunk sewer will be a series of storage tanks, to be filled during periods of maximum flow and discharged when the normal flow from the several towns is at a minimum. It is estimated that this plan will be equivalent to a 50% increase in the size of the outlet sewer.

THE PASSAIC VALLEY SEWERAGE DISTRICT has been created by the legislature of the state of New Jersey. The district comprises the lower Passaic Valley, from Paterson to Newark, inclusive. Under the provisions of a companion measure, the Hon. Franklin Murphy, Governor of New Jersey, will appoint a district sewerage commission of five members, to serve for from one to five years each, at a salary of $2,500 a year each. The commission will have full control of water pollution throughout the district and will be charged with the duty of devising a plan to prevent the further pollution of the lower Passaic River. The expenditures of the commission will be limited to $50,000, until succeeding sessions of the legislature authorize it to exceed that sum. The amount actually expended under the present act will be borne equally by the State of New Jersey and the taxpayers of the district.

THE PROGRESS OF THE SEPTIC TANK throughout the world is partly indicated by statements made at the recent annual meeting of the Septic Tank Syndicate, at Exeter, England. This company, the report states, had 180 installations completed or under construction at the close of 1901, against 120 a year before. The profits of the company were placed at about $20,000 in 1901 and $15,000 in 1900. The Foreign and Colonial Syndicate, which appears to control the interests of the Septic Tank Syndicate outside Great Britain, reported the formation of a company for Denmark, another one to exploit French rights, which has already installed a test plant at Paris, and a third company covering three American states.

GERMAN COMMERCIAL PROGRESS IN PALESTINE is noted by U. S. Consular Agent E. L. Harris, of Eibenstock, Germany. Three years ago a German bank was established in Jerusalem, and in 1901 this bank exchanged $15,000,000. German motor boats ply on the Dead Sea, opening communication between Jerusalem and Kerok, on the caravan route across the Arabian desert. Germany is also promoting the Bagdad Railway, though it is here meeting the antagonism of England and Russia, for commercial and political reasons.

A CENTRAL ASIAN INLAND SEA is proposed in an elaborate project worked out by M. Demchenko, a Russian engineer. He proposes to dam the Obi River, now wasting its waters to the north, at its junction with the Vasingan River, and to dam the Tobol River at its junction with the Irtish. He would join the two reservoirs thus made by a short canal, and make a lake 356 ft. above sea level, or 200 ft. above the present Sea of Aral. As the waters spread he would cut through the watershed to the south by an 18-mile canal—and thus lead the water to the Sea of Aral. Counting ten years to finish the work, and the expenditure of $150,000,000, he expects that in one generation thereafter the area of the Sea of Aral would be increased over six times, and that the overflow would double the area of the Caspian Sea, now 85 ft. below sea level. As compensation for this outlay he would expect that over an area of 300,000 sq. miles the rainfall would be so increased as to change unproductive steppes and deserts into a country habitable by a settled population. The project would only interfere with a few minor towns and some thousands of nomads.

THE AREA OF THE UNITED STATES, according to the Twelfth Census, is 3,660,822 sq. miles, including the "outlying districts" of Alaska, Hawaii, Porto Rico, the Philippine Islands, Guam and Samoa. Of the total area just given, 2,970,230 sq. miles lies within "Continental United States" and the balance in the sections named, which range from 590,884 for Alaska to 201 for Samoa, and 81 for the Isle-of Pines, not mentioned separately above. The areas for continental United States include land surface, only, but for the outlying districts they include both land and water surface. The figures given vary somewhat from those reported by other government departments. For continental United States the U. S. Land Office gives an area of 2,354 sq. miles in excess of the Census Office, and for all the territory within our jurisdiction an area 35,688 sq. miles greater. The bulletin in question discusses areas, both geographically and topographically, compares our areas with those of foreign countries, and also goes into questions of population. Those who are further interested in the subject may consult Census Bulletin 149, "A Discussion of Area and Population."

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a butting collison near Jarvis, Ont., Canada, on the Wabash R. R., which occurred on March 28. An eastbound freight train failed to stop at Jarvis to permit a westbound freight to pass, and the collision was the result. Three men were killed in the wreck.

DISASTROUS FLOODS DUE TO HEAVY RAINS are reported from the central and eastern parts of Tennessee and Kentucky. The rainstorm seems to have been general over that region on March 28; following it, rivers and creeks rose to phenomenal height. Bridges and culverts were washed out and towns inundated. The village of Harriman, Tenn., was almost entirely destroyed. Communication was practically paralyzed throughout the affected districts. A number of lives were lost in the floods; although exact reports are not yet in, it is feared that as many as a score of persons perished.

A FATAL TROLLEY-CAR COLLISION occurred on the Joliet and Chicago Electric Ry. on March 28. Two cars going in opposite directions at high speed crashed together some 20 miles from Joliet; two men were killed outright, another died soon after, and a number of other persons were injured more or less severely. A very heavy fog prevailing at the time prevented the motormen from seeing ahead, but no direct reason for the accident is yet known.

A SEVERE WINDSTORM IN PITTSBURG did much damage on March 30. The storm came up the Ohio valley, moving eastward, and was very concentrated, lasting not over half an hour. Chimneys and stacks were blown down, houses, churches and factory buildings unroofed, a tugboat capsized, and much minor damage done. Several persons were injured, some of them probably fatally.

A MINE EXPLOSION killed 22 persons at Dayton, Tenn., on March 31. The disaster occurred at the Nelson mine of the Dayton Coal & Iron Co. It appears that, contrary to the rules, the day's blasts were fired before the men were all out of the mine; one of the blasts was fitted with a defective fuse, which blew so as to ignite the gas in the mine. The explosion of the gas caused a general and terrific detonation of coal dust so violent that three men standing outside of the mine were killed. In all 22 are dead, and a number of others were severely injured.

THE PARK AVENUE PROPERTY HOLDERS who suffered by the late rock-slide near 37th St. on the subway work have appointed a committee, with power, to request that the Rapid Transit Commission stop work in this part of the tunnel until the committee's engineers have inspected and reported upon conditions as found. Meanwhile the damaged section of the tunnel has been cross-walled at either end and filled up, and cement grout is being pumped into the fissured rock and into the tunnel packing from below and above. It is the purpose of the subway engineers to thus provide a solid mass through which the tunnel will be again driven. The committee of citizens referred to is now at work trying to locate responsibility for the accident and to ascertain who is liable for the damage sustained.

THE TUNNEL ENTRANCE TO NEW YORK CITY projected by the Pennsylvania R. R. has received sanction in a bill passed by the New York Legislature. The bill permits the authorities of New York city to grant a perpetual franchise to the company for the construction of its proposed tunnel, but provides that the compensation to be paid for the franchise shall be readjusted every 25 years.

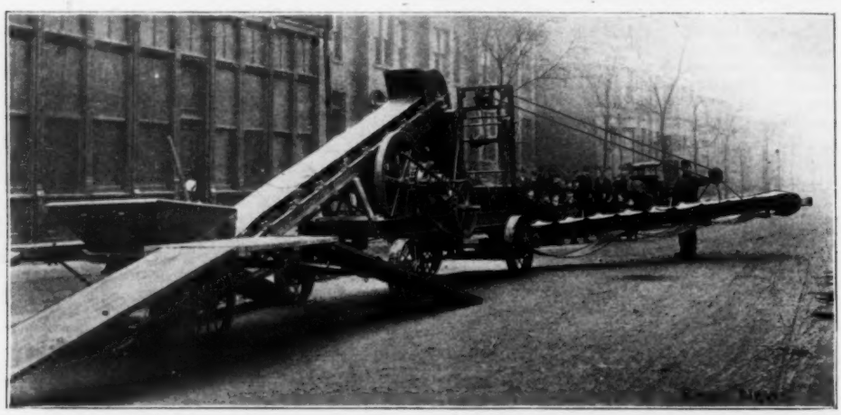
THE LIVERPOOL OVERHEAD RAILWAY, 6½ miles long, and equipped about ten years ago with the third-rail system, has been recently experimenting with three-car trains equipped with four 100-HP. new type enclosed motors. These motors have proved satisfactory and they have been adopted for the entire system. The motors are entirely encased in steel shells, journaled at one side to the driving axle and spring-supported on the truck frame on the other side. The makers guarantee to run the 6½ miles, including 16 stops of 12 seconds each, in 20.9 minutes, or at a rate of nearly 19 miles per hour. They make this trip easily in 20½ minutes. The motors were designed by Mr. Sydney H. Short to meet the requirements and specifications of the company. They were made by the English Electric Mfg. Co., of Preston, but are not described in detail in "The Engineer," from which this item is taken. This journal says that the total cost for power works out at 3d. per train-mile, and the motors weigh only 42 lbs. per horse-power.

THE ELECTRIFICATION of the Manhattan Elevated Ry. is progressing toward speedy completion. The Second Ave. line has been operated by electricity for the past month, and during the last week the first regular electric train was run over the Third Ave. line. The west side lines will probably not run electric trains for some months to come, as the substations for supplying them are still far from completion. The machinery in the main power house is nearly all in place, and portions of the installation have been running regularly for over a month. It is confidently expected that the whole work will be completed and in operation by fall. The main power units of the system were described in our issue of Jan. 30, 1902.

THE SPECIAL FRANCHISE TAX VALUATIONS for the city of New York amount to $220,620,155 for the current year, or an increase of a little more than $10,000,000 over the year 1901. The highest single valuation is $41,700,500, against the Manhattan Railway Co., which owns the elevated railways. The Metropolitan Street Railway Co. is assessed at $16,110,000, but if the lines it controls were added the total would, presumably, exceed that of the Manhattan Co.

CONCRETE MIXING AND DEPOSITING MACHINE FOR STREET WORK.

Concrete machines which not only mix the concrete but convey it and deposit it in place have been used on several important pieces of work, as described and illustrated in our issues of Feb. 28, and Dec. 26, 1901. The latest machine of this kind, however, is intended for the construction of concrete foundations for street paving, and embodies several improvements over earlier machines. The machine consists of a steel wagon frame mounted on four wide-tired wheels with steel spokes. At the front of the machine is a 20-in. belt conveyor for materials, the lower end of which is carried by a third pair of wheels. At the rear end is a concrete mixer, over which is an upright frame with pulleys and a hand-hoist for the rope supporting the pivoted steel boom, on which runs a 20-in. rubber delivery belt. Behind the concrete mixer and under the material conveyor is a 12-HP. gasoline engine, which operates the conveyors and mixers and propels the machine when at work.



CONCRETE MIXING AND DEPOSITING MACHINE FOR STREET PAVING FOUNDATIONS.
Drake Standard Machine Works, Chicago, Ill., Makers.

The accompanying cut shows the machine in its working position. The materials are carried or wheeled up the inclined planes on either side of the conveyor and dumped into the steel measuring box over the lower end of the conveyor. When the required quantities have been loaded into the box, the upright lever is pulled, opening a gate and discharging the contents upon the conveyor belt. At the head of the conveyor the materials are delivered by a chute into the Drake concrete mixer, having horizontal shafts with a series of blades which not only mix the materials, but force them outwards to the rear of the machine, where the finished concrete is deposited upon the conveyor belt of the steel boom, 20 ft. in length. The machine works along the middle of the street, and an attendant slowly swings the boom from side to side so as to deposit the material over the full width of the street and to the required depth.

The machine weighs about 9 tons, and will deliver about 200 cu. yds. per day. It is manufactured by the Drake Standard Machine Works, 300 Jackson Boulevard, Chicago, Ill., and we are indebted to the makers for photographs and information.

THE PRESENT ORGANIZATION OF THE U. S. COAST AND GEODETIC SURVEY.

The important work in surveying and mapping the coast waters of the United States, which is being carried out from year to year by the U. S. Coast and Geodetic Survey, is familiar to the great majority of our readers. Many of them also know in a general way the character of the organization which the Survey has adopted to prosecute this work, but we presume that few are familiar with the details of this organization. To many, therefore, the following statement of the present organization of the Survey, which has been furnished to us by Mr. O. H. Tittmann, Superintendent, U. S. Coast and Geodetic Survey, will doubtless prove of interest.

The United States Coast Survey first became permanent in 1832, although the original act providing for a survey of the coast and making an appropriation for that purpose was passed in 1807. A formal reorganization took place in 1843, in which the plans for the survey which had been formulated and acted upon in former years by F. R. Hassler, the first Superintendent, were continued in force. The scientific organization of the Survey may therefore be properly said to date from 1832. The minor details of the organization have been changed at various times, so that the present organization is in part the result of a gradual evolution.

The original and the principal purpose of the organization is a survey of the coasts of the United States primarily for the benefit of commerce. It is charged with the duty of publishing all results of such a survey that may be useful to the public. There has been added to its original duty, by legislation, that of determining the magnetic elements, exact elevations and geographical positions of the interior. In 1878 the name of the organization was changed by Congress from Coast Survey to Coast and Geodetic Survey in recognition of the extension of its functions to include triangulations in the interior.

The Coast and Geodetic Survey is a Bureau of the Treasury Department; the head of the Bureau, called the Superintendent, reports to the Secretary of the Treasury. The Superintendent is charged with full responsibility in every respect for all the work of the Bureau. He is aided in such of his duties as cannot be delegated to officers of lower rank in the organization, by an Assistant Superintendent, who acts as Superintendent in his absence.

Eight officers or groups of officers report directly to the Superintendent and Assistant Superintendent, viz.: (1) The Assistant in Charge of the Office; (2) The Inspector of Hydrography and Topography; (3) Inspector of Geodetic Work; (4) The Inspector of Magnetic Work; (5) The Disbursing Officer; (6) The Editor; (7) The Chiefs of Field Parties, and (8) The Heads of Sub-Offices.

The first four of these officers have a general supervision over all the operations of the Survey, both in the field and office, each acting as an advisory officer to the Superintendent in regard to specified portions of the work. The functions of the fifth and sixth officers are stated fully in the last paragraph of this article. The officers in groups (7) and (8) have direct charge of all operations in the field.

Each field party is a temporary organization which is created for a specific operation by an order of the Superintendent, which makes one of the officers of the field force the chief of party, and, if necessary, assigns to him as subordinates one or more other officers from the same force. The party is disbanded when the work assigned to it has been completed. If the party is for duty on land, the remainder of the organization of the party, the hiring of recorders, laborers, drivers, etc., is left entirely to the Chief of Party. If the party is for duty on a vessel, the assignment of an officer of the field force to command the vessel carries with it, necessarily, the command of the whole force on board the vessel, including watch and deck officers as well as crew. There are at present 60 officers on the field force. These officers are subject to office duty between field seasons. The Survey has its own fleet of twelve steamers and six sailing vessels, aside from launches and other small craft.

There are at present three sub-offices, each in charge of a field officer reporting directly to the Superintendent, viz.: at Seattle, Wash., San Francisco, Cal., and Manila, P. I. The purpose of these sub-offices is to aid in the prompt dissemination of information, to serve as storage depots and to save traveling expenses by providing points at which the field officers may be temporarily assigned to office duty between the seasons. At the Manila sub-office the publication of preliminary charts is authorized.

The Inspector of Hydrography and Topography reporting directly to the Superintendent, has supervision over the classes of field work [illegible] his title, places before the Superintendent plans [illegible] work, makes the necessary inspection in the field [illegible] that the Superintendent's orders are carried out [illegible] cally and effectively; and is especially charged [illegible] supervision of all matters relating to the ships [illegible] personnel. The "Coast Pilot," a publication [illegible] descriptions of the coast from the mariner's point [illegible] sailing directions, warnings as to dangers to [illegible] and other information of special value to navigators [illegible] prepared under his direction.

The Inspector of Geodetic Work reporting to the Superintendent is charged with the duty of preparing [illegible] the field operations of triangulation, astronomical determinations and precise leveling, and of making [illegible] of parties in the field, and of records and correspondence received at the office from field parties, with a view to insuring that the field operations are in accordance with the Superintendent's orders, are of the desired degree of accuracy, and are efficient and economical. The Inspector of Magnetic Work, reporting to the Superintendent, is charged with similar duties in regard to the magnetic work of the Survey.

The Assistant in Charge of the Office, reporting to the Superintendent, has charge of the office at Washington, is responsible for the safety and arrangement of all records and property, and receives all money paid to the Survey for charts and other publications. As the official head of the office, the chiefs of the following divisions of the office force report to him: Computing Division, Magnetic Division, Tidal Division, Drawing and Engraving Division, Chart Division, Library and Archives Division, Instrument Division and Miscellaneous Division.

Each of these Divisions, under the direction of the Assistant in Charge of the Office, prepares replies for the Superintendent's signature, to such parts of the correspondence as fall within its particular field, and also furnishes such information and equipment to field parties as it is within their power to furnish.

In the Computing Division, all computations in connection with triangulation, astronomical determinations and precise leveling are made, appropriate registers of results are kept, and the results prepared for publication as rapidly as possible. The Magnetic Division and the Tidal Division deal similarly with the computations and publication of magnetic and tidal results, respectively.

The Drawing and Engraving Division is divided into five sections: (1) The photographing section, engaged in reducing, enlarging and reproducing drawings for various purposes. (2) The drawing section, engaged in making from the original topographical and hydrographical field sheets, the office drawings, which are the original from which charts are produced, either by engraving on copper or by photolithography. (3) The engraving section, engaged in copper plate engraving. (4) The electrotype section, engaged in producing from the original engraved copper plates by electrotype process, the copper plates actually used in printing the charts. (5) The printing section, engaged in printing charts from the copper plates (the lithograph printing is done by contract outside of the organization).

The Chart Division is divided into two sections: the Hydrographic Section is engaged in completing unfinished hydrographic sheets sent in from the field, corrections of charts, especially with reference to aids to navigation (lights, buoys, etc.), preparation of "Monthly Notices to Mariners" in regard to this matter, and the inspection of charts in their various stages of preparation. The chart section, is engaged in applying such hand corrections to charts at the last opportunity before issuing as have become necessary on account of such changes, principally in the aids to navigation, as have taken place after the chart was printed; and with the clerical work connected with the issue and sale of charts.

The Library and Archives Division has charge of the Library of the Survey and the archives in which all hydrographic and topographic sheets and all the original records and computations are stored. The Instrument Division has charge of all the instruments and general property. Many of the best of the new instruments for the Survey are made in this division, and it is continually engaged in the repairing and remodeling necessary to keep the instrument outfit at a high standard of efficiency.

The Miscellaneous Division is charged with the purchase and distribution of all supplies required for use in the office, and of such supplies as are furnished to field parties on requisition; also, with the marking of requisitions for printing and binding, the custody of blank forms, stationery, etc., and the distribution of the Reports of the Superintendent and of all other publications of this Bureau, with the exception of charts.

As already noted, the Accounting Division, at the head of which is the Disbursing Officer, is not a division of the office in the sense of reporting to the Assistant in Charge of the Office. The Disbursing Officer makes all disbursements on account of the Survey, with the approval of the Superintendent, renders a monthly account of all such disbursements to the Auditor for the Treasury Department for audit by him, renders a statement of

expenditures and balances to the Superintendent whenever required to do so, suspends returns for correction or disallows under the Superintendent's direction all items of expenditure irregular in form or in contravention of law or regulations, and refers to the Comptroller of the Treasury, for decision, all questions of law involving a payment to be made by him.

The Editor, reporting to the Superintendent, compiles the administrative part of the annual report, and acts as editor in connection with all other publications of the Survey, except the charts.

A 325-TON HOT-METAL MIXER.

By Arthur C. Johnston,* M. E.

Hot-metal mixers are used in connection with steel works which are so situated that the iron from the blast furnaces can be converted into steel "direct:" that is, without casting and remelting. The mixer serves the purpose of a storage tank from which the supply of hot metal for the converters is drawn, and also insures a much more uniform grade of iron, since several casts are mixed together and their inequalities neutralized. In order to secure a continuous supply of hot metal sufficiently uniform in regard to its different chemical constituents, the storage tank should have a capacity of at least four blast furnace casts, so that for stacks of the 500-ton class, making six casts of 80 tons per day, the mixer should have a capacity of 320 tons. The design of a vessel capable of holding continuously this amount of molten iron has many interesting features.

The first mixer had a capacity of 100 tons, and was built at the Edgar Thompson works of the Carnegie Steel Co. in 1888. This experiment proved so successful that many tanks of larger capacity have since been built, and the design of mixers has been more fully developed. In Fig. 1 is shown the general outline of the original Edgar Thompson mixer. This vessel had flat sides and bottom, and was heavily braced by beams and buckstays to resist the internal pressure. It was mounted on trunnions, and was tipped for pouring by means of a segmental rack and pinion.

In Fig. 2 are shown the chief features of a very successful design of vessel of 325 tons capacity. The bottom of this tank is circular, and it is mounted on two sets of rollers, which conform to the shape of the cast-steel tracks which are secured to the bottom of the tank As the center of the arc formed by these tracks and the center of the mixer coincide, the vessel is virtually pivoted about this point when being tipped, while the total load is distributed over all the rollers instead of being concentrated on trunnions, as in the case of the Edgar Thompson mixer.

The sides and bottom of the vessel are formed of steel plates 1 in. thick, securely riveted together. The sides are tied at the top by means of

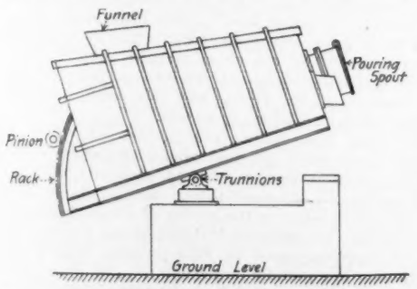


Fig. 1. Original Hot-Metal Mixer at the Edgar Thomson Steel Works; 100 Tons Capacity.

the 10-in. I-beams in the roof, and they are secured at the bottom by 6 × 6 × ⅞-in. angles in the corner. The bottom is stiffened by 12-in. I-beams, but no stiffeners are required on the sides, as they are swelled to the radius shown. The pouring spout, with its eccentric load of hot metal, is balanced by cast-iron counterweights placed at the opposite end of the mixer. The bottom and sides have a fire-brick lining 18 ins. thick and the roof 14 ins. thick. It will be observed that the roof is arched in both directions. This is a very important point, as in several of the large mixers a great deal of trouble has been caused by bricks dropping out of the roof when the arch was carried over in one direction only, as the action of the intense heat is very racking. On this account the work of lining the vessel must be very carefully done, as it will be readily understood that the results of even a small leak would be disastrous. The thrust from the top arch is taken up by the tie rods which pass just beneath the 10-in. I-beams to which they are attached, and these beams also carry the vertical component of the stress in the rods.

The arch over the pouring spout has sufficient rise to prevent the lining at this point from being submerged in the hot metal when pouring, and as this arch also carries part of the thrust from the longitudinal arch of the roof, it is backed up by an arched steel casting, to which the tension rods of the roof are secured. It will be observed

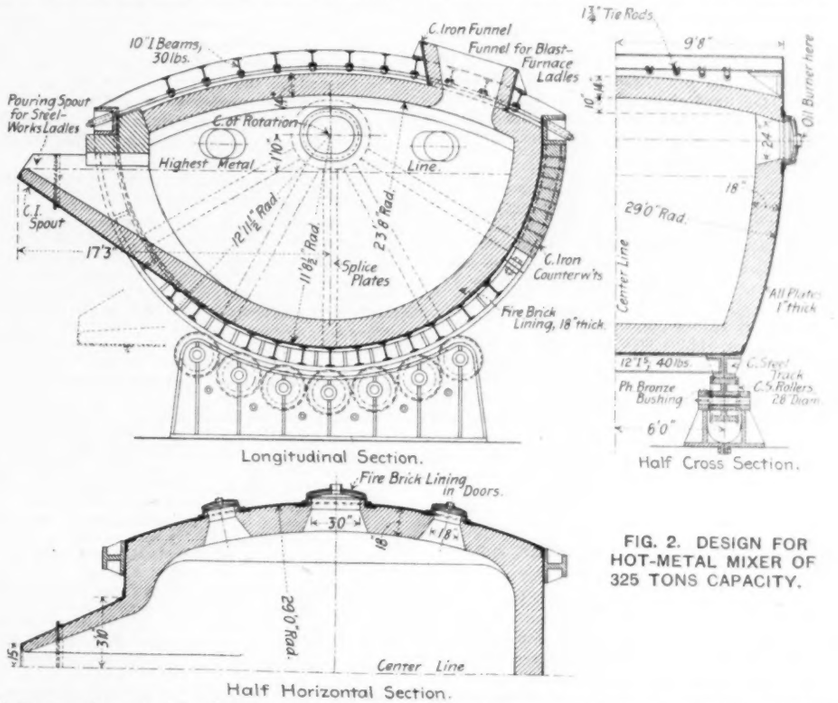


FIG. 2. DESIGN FOR HOT-METAL MIXER OF 325 TONS CAPACITY.

that the pouring spout is almost as wide as the vessel at the point of its junction with the latter. It is made so in order to allow the scum which floats on top of the molten metal to be easily drawn off into the steel works ladle; otherwise, it is a very difficult matter to get rid of this accumulation. With the wide spout, however, this is very easily accomplished, as in case the scum does not run out freely with the flowing metal, the attendant can easily draw it off with a long rod, since all corners are accessible. The hot metal from the blast furnace ladles is poured into the tank through a funnel-shaped mouth placed at the end of the mixer opposite to the pouring spout, and this mouth is well lined with fire-brick to protect it from the splashing that cannot be avoided in emptying the ladles. It will be observed that the funnel and the end of the pouring spout are made of cast-iron. These are the parts that are most liable to be destroyed by contact with the molten metal, and by having a pattern for these on hand spare castings can be obtained from time to time to replace those damaged.

The heat necessary to preserve the temperature of the hot metal is supplied by three fuel oil burners, one of which is inserted into the pouring spout and into each of the circular openings at the center of rotation of the vessel. These burners have universal joint connections to the steam and oil supply pipes, so that they can be withdrawn when not in use. The vessel is tipped for pouring by means of two single-acting hydraulic cylinders operating on a common plunger, to the cross-head of which a connection is made by a rod to the bottom of the mixer.

*Bristol, Pa.

PROPOSED NEW GAS PLANTS IN PARIS.

The unsatisfactory nature of the gas supply of Paris, resulting lately in a rupture with the old Gas Company of Paris, has led the municipal authorities to seriously consider the construction of new works. Mr. Lauriol, Chief Engineer of the City Lighting Department, has made a report on this head, and from this report the following points are gleaned:

The projected plant should have a daily capacity of 1,500,000 c. m. of coal gas, demanding the consumption of 5,000 tons of coal per day. As the supply of material means the handling of 15 trains per day of 400 tons each, or 20 boats of 300 tons capacity each, it would not be prudent to concentrate all this traffic at one spot, subject to accidents by rail or to the blocking of ways of water communication. Mr. Lauriol therefore proposes three separate plants, at Vitry, Boudy and Gennevilliers, each having a daily productive capacity of 500,000 cu. m. of gas.

After treating of the coal storage bins, gas furnaces, coke produced, etc., the work of distribution is taken up. The mean distance between the producing plants and the city would be 3.72 miles, or 6 km.; and it is proposed to lay two 1.2 m. conduits from each plant, the gas to be delivered in the city under a minimum pressure of 35 mm. on the water gage.

The estimated cost of the new works is as follows:

	Francs.
Cost of the plants proper	181,000,000
Completion of the distribution	7,000,000
Meters, connections and lampposts	36,500,000
The completion of meters, connections, etc.	15,000,000
Total estimated cost of works	239,500,000

Of this $47,900,000 the estimated amount to be paid by the City of Paris would be $3,000,000, provided some private company built and operated the works and did not utilize the old works. If the City of Paris should conclude to build the new works itself throughout it would have to add interest and sinking fund provisions to the above estimate and the actual cost would be about $50,000,000.

Mr. Lauriol estimates the cost of coal gas per cubic meter as follows, under the old system and with the proposed new works:

	Works— Old, centimes.	New, centimes.
Fuel	1.43	1.27
Hand labor	1.79	1.04
Repairs	0.64	0.84
Purification, etc.	0.53	0.53
Total	4.39	3.68

This would amount to about 24 cts. per 1,000 cu. ft. for the old works, and 20 cts. per 1,000 cu. ft. for the new plant as the actual cost of manufacture at the works, without cost of distribution, superintendence, etc. It is assumed that the latter cost would be the same under both systems, and Mr. Lauriol figures, with an estimated leakage of 7%, the following net cost to the consumer under the two systems per cubic meter of gas:

Expenses:	Works— Old, centimes.	New, centimes.
Coal	6.61	6.31
Manufacture	4.39	3.68
Distribution	1.71	1.71
Sundry expenses	1.79	1.79
Total	14.50	13.49
Receipts: By-products	5.67	5.57
Sundries	0.49	0.49
	6.16	6.06
Net cost of gas produced	8.34	7.43
Allowance for leakage	0.58	0.52
Net cost of gas to consumer	8.92	7.95

The cost figure furnished for 1899 by the Gas Company of Paris was 8.40 centimes per cu. meter, or about 46 cts. per 1,000 cu. ft. In taking into account the fixed charges on investment, with a sufficient margin, Mr. Lauriol fixes the following selling price of gas to the consumer, under the two assumptions given:

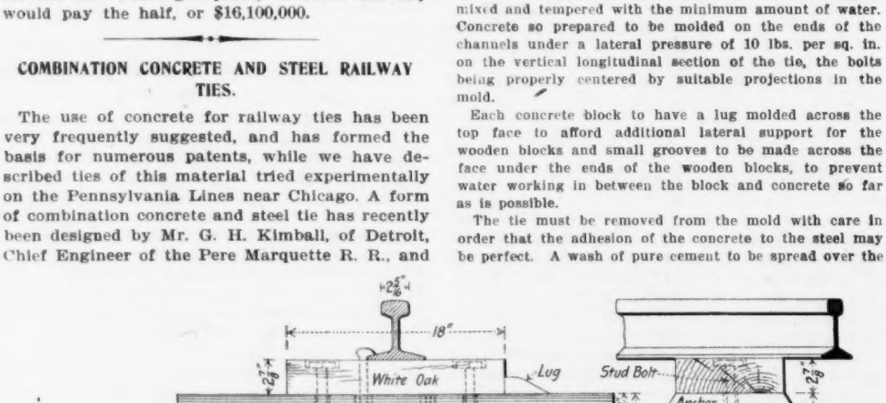
	Centimes.
Price, with an entirely new plant and no profits for the communes, per cu. m.	14
Price, allowing communes same profit as received by city of Paris; or special price of 15 centimes for all gas used by municipality, cu. m.	20

These two statements would make the selling price of gas in Paris 76.5 cts. and $1.12 per 1,000 cu. ft.

The report values the existing works at 70,000,000 francs, or $14,000,000, as compared with new works of equal capacity costing 158,000,000 francs. The present distribution system is valued at 73,000,000 francs, or $14,600,000. Deducting the value of the old plant from the cost of the new, and allowing for the distribution, as above, gives a total cost of 161,000,000 francs, or $32,200,000 for the new Paris gas plant, of which the city would pay the half, or $16,100,000.

COMBINATION CONCRETE AND STEEL RAILWAY TIES.

The use of concrete for railway ties has been very frequently suggested, and has formed the basis for numerous patents, while we have described ties of this material tried experimentally on the Pennsylvania Lines near Chicago. A form of combination concrete and steel tie has recently been designed by Mr. G. H. Kimball, of Detroit, Chief Engineer of the Pere Marquette R. R., and a few experimental ties have been made and put in the track. Orders have also been placed for steel for making enough ties with which to lay 1½ miles of track this season. This tie has been patented, and Mr. John Doyle, Superintendent of Tracks, and Mr. McWain, Signal Inspector, are equal owners with Mr. Kimball in the patents. In this tie, which is shown in the accompanying cut, Mr. Kimball has returned to the old practice of using separate supports for the rails, connecting these supports by transverse bars. This principle is employed very extensively with cast-iron plate and bowl ties in India and elsewhere, but while in these metal ties the wrought iron or steel bars are separable from the cast-iron rail supports, in Mr. Kimball's tie the steel bars and supports are rigidly connected to form one single piece or tie.



CONCRETE-STEEL RAILWAY TIE.

G. H. Kimball, Chief Engineer, Pere Marquette R. R., Detroit, Mich., Designer.

Each tie is composed of two concrete blocks 3 ft. long, 7 ins. deep and 9 ins. wide on top and bottom, while the sides are convex, with a radius of 5.7 ins. The blocks are 1 ft. 11 ins. apart, and are connected by two steel channels 1¼ × 3 ins., weighing 4½ lbs. per ft. These are set back to back, 2 ins. apart, and extend to within 1 in. of the ends of the blocks. Upon each concrete block is a wooden cushion or spiking block, 9 × 18 ins., 2⅞ ins. thick, secured by tap bolts or studs screwed into anchors embedded in the concrete. These anchors have lugs which have a driving fit in holes in the webs of the steel channels. Lateral motion of the wooden block is prevented by a lug formed on the concrete. The rail is laid directly upon the wooden block and secured by the ordinary form of spike, driven through the block and into hollow elm spiking plugs embedded in the concrete.

The following extracts from the specifications explain the construction:

The channels may be rolled from crop ends of steel rails, from old steel rails or from steel rail scrap, and must be kept and shipped under cover to prevent corrosion; a clean surface being essential to insure the adhesion of the concrete. That portion of the channels between the concrete blocks that would otherwise be exposed to corrosive action, will be treated with two coats of best Portland cement, pure, and in liquid form of a creamy consistency, before the concrete blocks are molded in place; the space between them to be also filled with concrete.

Concrete shall consist of 2 parts of the best American Portland cement and 3 parts of clean bank gravel of a medium grade that will pass through a ¾-in. wire mesh, and one part of clean sharp sand, all very thoroughly mixed and tempered with the minimum amount of water. Concrete so prepared to be molded on the ends of the channels under a lateral pressure of 10 lbs. per sq. in. on the vertical longitudinal section of the tie, the bolts being properly centered by suitable projections in the mold.

Each concrete block to have a lug molded across the top face to afford additional lateral support for the wooden blocks and small grooves to be made across the face under the ends of the wooden blocks, to prevent water working in between the block and concrete so far as is possible.

The tie must be removed from the mold with care in order that the adhesion of the concrete to the steel may be perfect. A wash of pure cement to be spread over the entire surface of the concrete while it is still moist. Plugs of elm or other suitable material, bored through with a ¾-in. hole to guide the point of the spike, shall be molded in place. When the wooden block is made of sufficient thickness these plugs may be omitted.

The blocks for cushion and spiking may be of oak, birch, beech, maple, southern pine or other close-grained hard wood. They must be cut from green or living timber, must be perfectly sound and free from check or shake. They must be thoroughly seasoned in the block, to be counter-bored on the top for the bolt heads (which are to be counter-sunk), and bored through for the body of the bolts, all before seasoning.

After seasoning they will be treated in a bath of Avenarius Carbolineum until they are thoroughly impregnated to a depth of at least ½-in. from the surface. When the blocks are secured to the concrete the counter-bore around and over the head of the bolt, together with the space around the body of the bolt, shall be filled with pitch to protect the metal and exclude water, all holes being bored large enough to make this possible.

One claim made for the ties is that they will not spring in the ballast when supported at the middle with the ends more or less free, but it is doubtful if this springing of wooden ties has much influence in causing the cutting of ties and spread of gage, and in any case it should not exist in a track that is properly ballasted and tamped. A stronger point is that renewals, and the consequent expense, will be greatly reduced, and that there will be less disturbance of the ballast and roadbed, as the rail blocks are easily removed, although the inventor states his belief that they will last as long as the rail. These ties are shown spaced 2 ft. c. to c., but this can be varied as desired. The ballast will be filled in between the blocks level with their tops, and then sloping down to give about 4 ins. clearance under the rail base.

A few ties have been placed between wooden ties in the track for experiment, and others have been subjected to breaking tests. A concrete block with steel channels was placed on supports 2 ft. apart, and failed under a load of 90,000 lbs., only a faint crack being then discernible. A similar block was placed within a large box containing gravel, so that the ultimate strength might be obtained under conditions resembling those in actual service.

The estimated weight and cost of the tie are given as follows by Mr. Kimball:

Iron and steel	68 lbs.	$0.74
Concrete	374 "	0.50
Wood blocks	10 "	0.12
Royalty		0.10
Total	452 lbs.	$1.46

A EUROPEAN TANDEM-COMPOUND ENGINE USING SUPERHEATED STEAM.

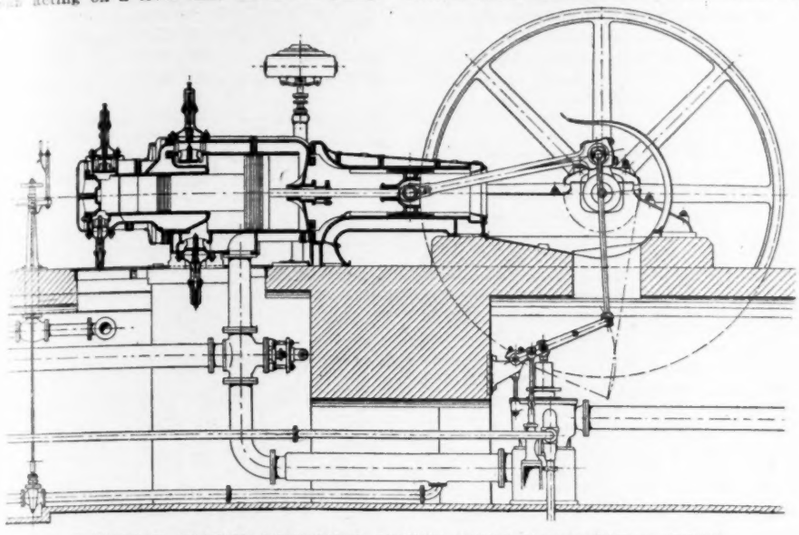
A peculiar type of engine designed for use with superheated steam is described in a recent issue of the "Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins." The engine is a tandem-compound, with poppet-valves operated as usual from a cam-shaft lying parallel with the cylinders and driven by bevel gears from the crankshaft. The rear, or high-pressure cylinder, is single-acting, i. e., steam acts only on the rear piston face. In accordance with this, the piston is constructed as a plunger piston in the high-pressure cylinder, and has an enlargement at its front end to form the low-pressure piston. The rear or annular face of this latter piston takes steam from the receiver and exhausts it into the condenser, in the usual manner; but the front, full-circular face, is under receiver pressure throughout the stroke, and this end is, therefore, not provided with any valves.

With this design, the number of valves required is only half that otherwise necessary; only one stuffing-box is required, moreover, and that one (in the forward low-pressure cylinder head) is not exposed to the action of the high-pressure steam. All troubles incident to the maintenance of stuffing-boxes in high-pressure superheated steam are thereby avoided.

The accompanying figure clearly shows the construction of the engine. It will be seen that there is only one set of valves for the high-pressure cylinder and one set for the low-pressure. The admission valve in each case is at the top, the exhaust valve at the bottom of the cylinder. It will be noticed that the passage leading the steam from the receiver to the low-pressure cylinder connects without intervening valve to the forward end of the latter, so that steam acts here throughout the stroke. This end, therefore, acts, in a manner, as part of the receiver.

The other details of the engine are less unusual. A dead-beat governor controls the admission to the high-pressure cylinder. The rear end of the low-pressure exhausts to a condenser located in the foundations. A by-pass to the atmosphere is

provided in the exhaust pipe to permit the engine to be run non-condensing. The condenser air-pump is driven directly from the crankpin by a pitman acting on a lever that works the pump



A EUROPEAN TANDEM-COMPOUND ENGINE USING SUPERHEATED STEAM.

rod. (As will be seen in the figure, the same lever also drives a small auxiliary feed-pump, the action of which can be controlled by a valved by-pass.) The engine is built single, as shown, but may be had either right or left hand. It is, therefore, possible to enlarge a steam plant by adding an engine of the opposite hand to the one already in place, and acting on the same crankshaft; the construction is carried out with this purpose in view. The efficiency of each half, it will be noted, is the same as that of the double unit, in contrast to the ordinary cross-compound method of installing one side, high-pressure first, and adding the other, or low-pressure side, when extension of the plant becomes necessary.

The engine is built under Schmidt's patents by the firm of Breitfeld, Danek & Co., located near Prague, Austria; the company has in the last four years built a considerable number of engines of this type, in sizes from 20 to 1,000 HP. Excellent results as regards operation and efficiency are stated to have been obtained. The main advantages claimed for the design are: (1) successful use of superheated steam at temperatures even as high as 650° F.; (2) consequent high effiriency, even in the smaller sizes, amounting in a number of recorded tests to 18% more than that of a first-class triple-expansion engine using saturated steam; (3) great simplicity of construction and operation, and, therefore, high reliability and perfect governing; (4) minimum oil-consumption.

POWER PLANTS OF THE ST. LOUIS TRANSIT CO.

The street railway system of St. Louis, like that of most other large cities, had its beginning in a number of small independent lines owned by different companies, and gradually extended to suit their individual interests without any general scheme or policy. In progress of time the companies began to be consolidated, and the separate lines linked up to form more or less coherent systems, and this process of consolidation reached its culminating point in 1898, when all the principal companies were consolidated in the St. Louis Transit Co., which now controls the entire street railway system of the city and its suburbs (with one exception), aggregating about 360 miles. The tracks are of different types of construction, but the standard type consists of 9-in. girder rails, laid directly on a 6-in. concrete foundation, the rails having steel ties and tie-rods, and having the joints either welded by electricity or spliced by the continuous cast-iron joint. This track construction is very satisfactory, and proves very easy riding. Wooden ties, laid 10 ft. center to center, are used to support the rails temporarily during the process of concreting. The equipment consists mainly of long double-truck cars, with rattan seats arranged as in steam railway cars. A frequent service is provided and the cars run easily and at good speed. Mr. Murray Carleton is President; Mr. Corwin H. Spencer, First Vice-President; Mr. A. B. Du Pont, Second Vice-President; Mr. James Adkins, Secretary; Mr. John Grant, General Superintendent; Mr. A. D. Cook, Superintendent of Power, and Mr. C. A. Mareno, Chief Engineer. The exception above referred to as not being included in the consolidation is the St. Louis & Suburban Ry. Co., which controls 60 miles of electric railway.

The various lines which were consolidated to form the St. Louis Transit company's system were operated from eleven different power stations, with an aggregate capacity of 24,275 HP. Four of these were cable plants, which are now useless, the cable lines having been converted to the overhead trolley electric system. Of the seven electric power stations, one has been wrecked, one closed down, and the others are operated intermittently until the two main plants are fully completed. What will then be done with them is not yet determined. Practically the entire system will be operated from two large power stations and one substation. The Northern station is an entirely new plant, as is the substation, while the Central station is one of the largest of the original power stations, greatly enlarged and improved. The power plants in these two stations will develop 23,500 HP. at the Central station and 14,000 HP. at the Northern station, making an aggregate of nearly 40,000 HP. at the most economical rating, or a maximum of about 57,000 HP. The accompanying map, Fig. 1, shows the location of the old and new power stations.

In the present number we describe and illustrate the Central Power Station, leaving the Northern Station to a following issue.

I.

THE CENTRAL POWER STATION.

The Central station, located at Vista and Tiffany Sts., near the main offices, shops and car sheds of the company, was first established by the Lindell Ry. Co. in 1883, and afterwards enlarged. Work on the further enlargement of the plant for the purpose of making it take the place of smaller plants to be abandoned was commenced in June, 1899, and the entire work was completed in October, 1901. The work was done under many difficulties, the alterations and reconstruction having to be done while the old plant was continued in uninterrupted operation, and much of the new machinery being required to be put in service as soon as it was installed.

Fig. 2 is a general plan of this station, and shows very clearly the arrangement of the power plant. The site occupied covers about three acres, and the buildings have a floor space of about 70,000 sq. ft. The engine room is located in the center of the group of buildings, with a boiler house and coal storage building on each side, and the cooling plant for the condensing water at one end. In the pump rooms are washrooms for the employees, with wash-basins, closets and individual lockers for clothes, etc. Modern sanitary plumbing is used. Fig. 3 is a view of this station, showing the north boiler house and its single steel chimney, while its cooling towers are at the right and its coal storage building at the left. The four smaller chimneys are those of the south boiler house, the engine house being between the two boiler houses.

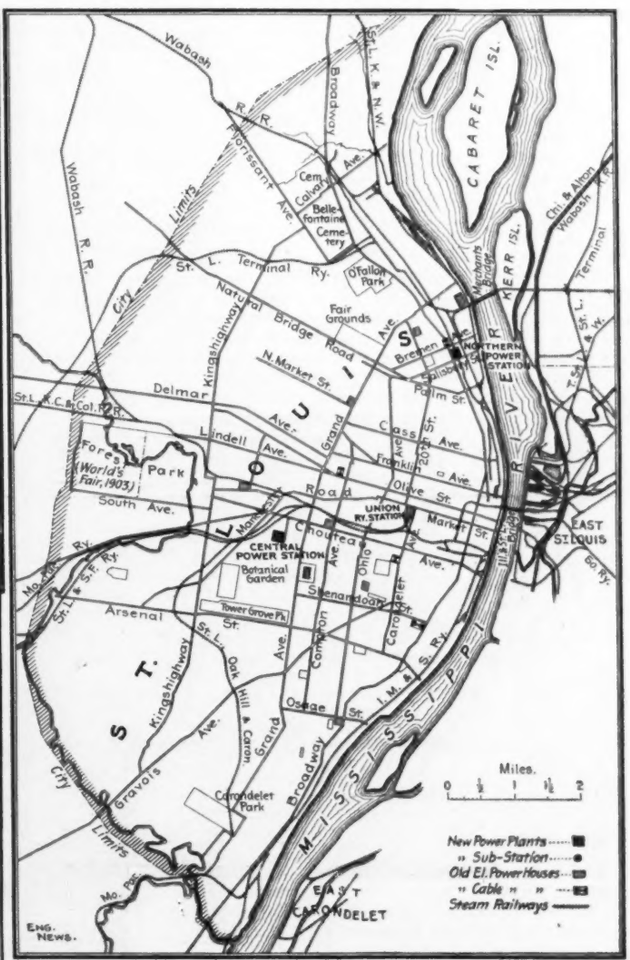


FIG. 1. MAP SHOWING LOCATION OF OLD AND NEW POWER STATIONS OF THE STREET RAILWAY SYSTEM OF ST. LOUIS, MO.

The buildings are of fireproof construction, with self-sustained steel framing and roof trusses, brick walls and concrete floor arches. The roof is of cinder concrete, covered with slate. The steelwork weighs approximately 1,412 tons. The

buildings are lighted by incandescent arc lamps and by the ordinary incandescent lamps, current for these being generated by two direct-current dynamos, each direct-connected to a steam engine.

(3) Three Porter-Allen tandem compound engines (Nos. 8 to 10), of 1,000 HP. each, with cylinders 22 and 38 ins. diameter and 36 ins. stroke; they have 13-ft. flywheels weighing 65,000 lbs., and run at 140 revolutions per minute.

1 load panel for direct current, and 1 for increased voltage. All the instruments are of the Westinghouse make, with the exception of General Electric wattmeters. The cables are led out through underground conduits.

The engine room has two of the Case Mfg. Co.'s electric traveling cranes of 75 tons capacity. The height of hoist is about 20 ft. The controllers are

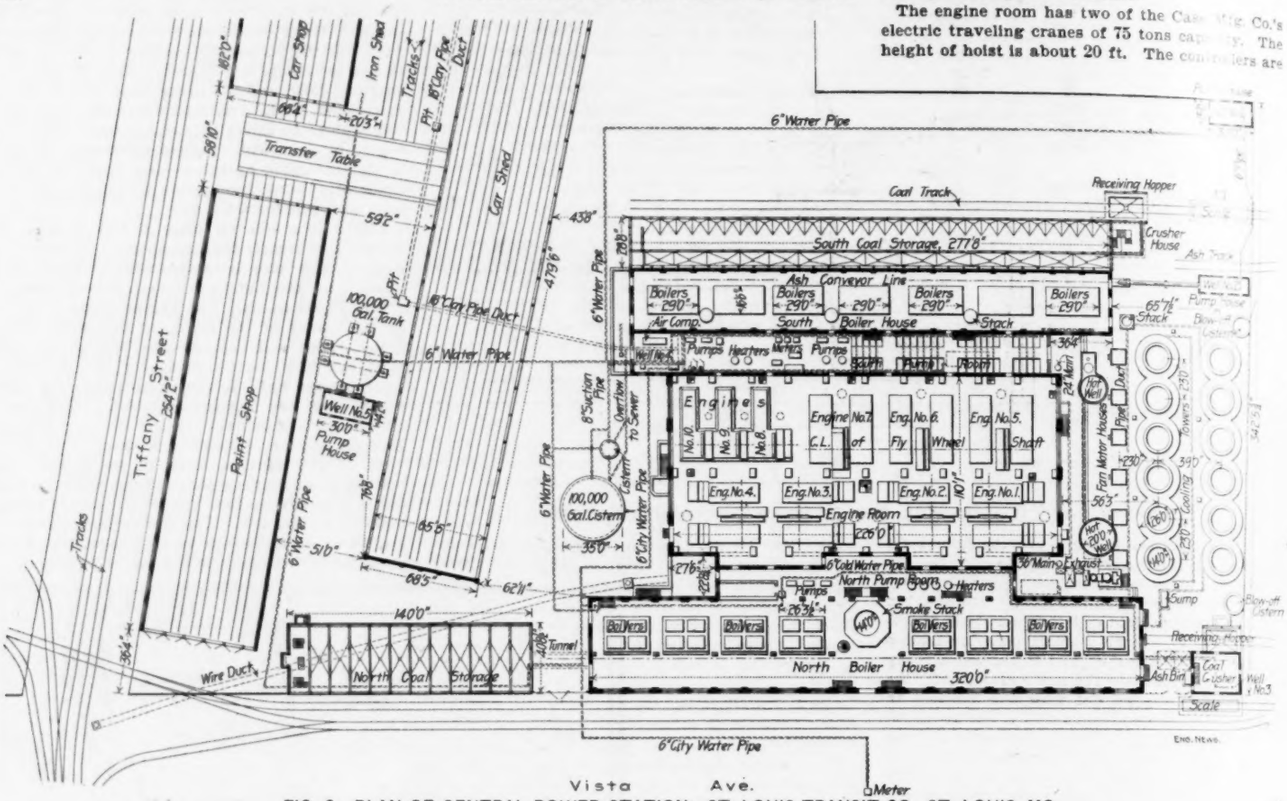


FIG. 2. PLAN OF CENTRAL POWER STATION; ST. LOUIS TRANSIT CO., ST. LOUIS, MO.
W. D. Boyce Engineering Co., St. Louis, Mo., Consulting and Supervising Engineers.

Water is supplied by six artesian wells, 500 to 600 ft. deep, each yielding 90,000 to 100,000 gallons per 24 hours. These are located at different parts of the plant. Each well has a Gould double-acting working-head driven by a belt from a 25-HP. electric motor. The pumps are geared 6 to 1, and have a capacity of 100 gallons per minute at 25 revolutions. Good boiler water is obtained from these wells, and any excess required is taken from the city mains. The storage cistern in the ground is 30 ft. diameter and 20 ft. deep, with a capacity of 100,000 gallons. There is also a circular wooden tank 18 × 30 ft., with a capacity of 86,790 gallons. This is supported by a steel tower 60 ft. high, having 12 columns of the Larimer type on concrete foundations. This was built by the U. S. Wind Engine & Pump Co., of Batavia, Ill.

ENGINES AND GENERATORS.—The engine room contains main steam engines having an aggregate capacity of 23,500 HP. at the most economical rating, or 36,500 HP. at maximum rating, while the generators are of 15,350 K-W. capacity, 28,130 amperes. The engine duty is based on 15 lbs. of steam per HP., with 24 ins. of vacuum on the condensers. The main power equipment is as follows:

(1). Four cross-compound Corliss engines of 3,400 HP., built by the Fulton Iron Works, of St. Louis; these have cylinders 36 and 70 ins. diameter, 60 ins. stroke, with 25-ft. flywheels weighing 170,000 lbs.; they run at 75 revolutions per minute, taking steam at 150 lbs. pressure. Each engine is directly connected to a Westinghouse direct-current generator of 2,250 K-W., 4,100 amperes. These are Nos. 1 to 4 on the plan.

(2) Three similar engines (Nos. 5 to 7), of 2,300 HP., by the same builders, running at the same speed and pressure; they have cylinders 32 and 62 ins. diameter and 60 ins. stroke, with 24-ft. flywheels weighing 140,000 lbs. Each is directly connected to a Westinghouse generator of 1,500 K-W., 2,730 amperes.

Each is directly connected to a Westinghouse generator of 650 K-W., 1,180 amperes.

In addition to the main engines and generators, the auxiliary equipment includes about 40 steam engines and electric motors, for various purposes.

The switchboard is in two parts, and is located on the second floor of the north pump room. The feeder panel board is 133 ft. 4 ins. long, with 80 panels 7 ft. 6 ins. high and 20 ins. wide. In front of this, and 7 ft. 3 ins. from it, is the generator board, 27 ft. 8 ins. long, with 12 panels; 4 for 250 K-W. machines, 3 for 1,500 K-W., 3 for 650 K-W., of the General Electric, and the motors of the Westinghouse make; 50 HP. for the hoist, 25 HP. for the trolley, and 25 HP. for the bridge; the speed is 3 to 5 ft. per minute for hoisting, 25 to 50 ft. per minute for the trolley, and 50 to 100 ft. per minute for the bridge.

CONDENSERS.—On the north side there is a

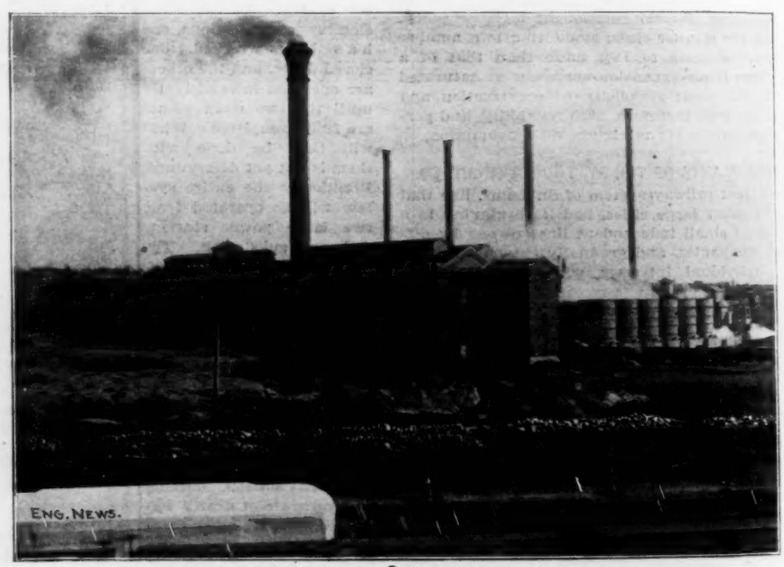


FIG. 3. CENTRAL POWER STATION; ST. LOUIS TRANSIT CO.

48-in. Worthington central jet condenser, with a 48-in. exhaust header, 24-in. injector pipe and 26-in. tail pipe to the hot well. This is shown in Fig. 4. It is operated by two independent rotative dry-vacuum pumps, with 10-in. steam

cylinder, 18-in. air cylinder and 10-in. stroke, running at 120 revolutions. There are three circulating units, each consisting of two centrifugal pumps (one for hot and the other for cold water) mounted on a shaft directly connected to a slide-valve engine. The pumps have 16-in. suction and delivery. In the main exhaust, between the last engine and the condenser, is a 48-in. Cochrane oil separator, made by the Harrison Safety Boiler Works, of Philadelphia; this cleanses the steam to such an extent that the water of condensation can be taken directly from the hot well to the feed water system.

Fig. 4. Worthington Jet Condenser.

On the south side there is a 36-in. Worthington central jet condenser, with 36-in. header, 16-in. injection and 18-in. tail pipe to the hot well. This takes care of the exhaust from the three 1,500-HP. and three 650-HP. engines. It is operated by three dry-vacuum pumps of the type above described, run at 120 revolutions. The air cylinder is directly on the engine, which has a belt pulley from which is driven a pair of 10-in. centrifugal pumps, forming a circulating system similar to that on the north side. There are three of these circulating units, all composed of Worthington apparatus. A 36-in. Cochrane oil separator is also used, as on the north side.

The two condensers are connected by a 36-in. by-pass, fitted with Kennedy valves in such a way that either condenser can be worked from either side of the station, or both can be worked together. Each exhaust header has a 36-in. free air exhaust, so that either side of the station can be run non-condensing if desired. The two hot wells, Fig. 5, are open concrete pits, lined with steel shells, and are 15 and 20 ft. diameter, and 12 ft. deep. From these the water is pumped to the cooling towers and also to tanks over each pump room, for supplying the feed water heaters. The water for the condensers is cooled by 12 Worthington cooling towers, 26 ft. diameter and 32 ft. high. The circulating systems to the towers, for both injection and suction, are so arranged that either system can operate the cooling plant. The towers are built on the ground, and the fans for each pair of towers are driven by a vertical steam engine with double cylinders 8×8 ins., running at 350 revolutions per minute. They are located in six separate brick buildings 9×9 ft. These engines were built by the St. Louis Steam Engine Co. Steam engines were adopted for this work on account of the desirability of varying the speed so as to vary the air currents according to the temperature of the atmosphere. With electric motors only three rates of speed are practicable, and the work is therefore less economical, but motors were adopted for the cooling plant at the Northern station (described below) on account of the towers being carried on the roof trusses, where steam engines would be liable to cause too much vibration.

BOILERS.—The steam is supplied by 30 water tube boilers. The north-side boiler house has 16 water-tube boilers of 400 HP., representing 6,400 HP. in all. These were made by the O'Brien Boiler Works Co., of St. Louis, and have tubes slightly inclined from the horizontal. Their rating is based upon 10 sq. ft. of heating surface per HP., and 20,000 lbs. of water evaporated per boiler per hour. These boilers have the Green traveling chain grates, 9 ft. long and 9 ft. 8 ins. wide, all effective grate surface; built by the Green Engineering Co., of Chicago. They are designed to burn 35 lbs. of coal (of 10,000 B. T. U.) per sq. ft. of grate surface per hour. They are driven by four Krieble engines of 8 HP. The south-side boiler house has 14 Stirling water-tube boilers, eight of 300 HP. and six of 325 HP., aggregating 4,650 HP. This is based on 10 sq. ft. of heating surface per HP., and burning 30 lbs. of coal (of 12,000 B. T. U.) per sq. ft. of grate surface per HP. per hour, evaporating 11,250 lbs. of water per hour. The Stirling boilers are equipped with Hawley down-draft furnaces. The boilers are all set in pairs.

The north boiler house of this station has a steel smokestack 202 ft. high and 14 ft. diameter. A description with detail drawings of this stack was published in our issue of Dec. 19. The twin breeching connected to this stack extends 150 ft. on each side of the stack, and contains 106,886 lbs. of steel. The south boiler house of the Central station has four steel smokestacks 160 ft. high; three of these are 7½ ft. diameter and the other is 5½ ft. diameter.

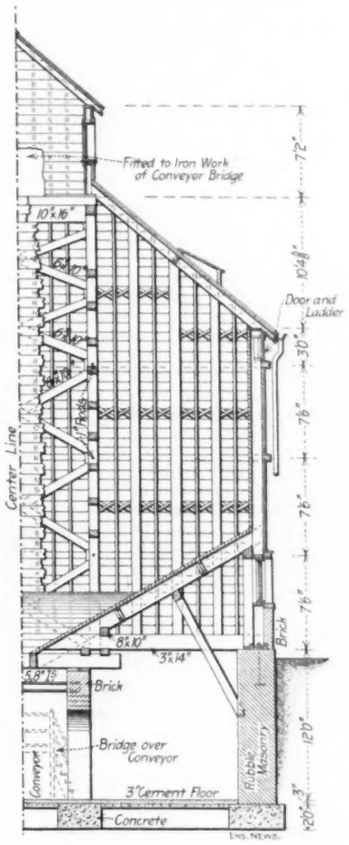


Fig. 7. North Coal Storage Building.

The north boiler house has four boiler feed pumps, one of which operates the turbines used for cleaning out the tubes. The south boiler house has the same number of pumps, and also two tank pumps. All of these are Worthington pumps.

METERS AND MISCELLANEOUS EQUIPMENT.—All the water supply is metered. The north pump room has three Hersey disk 4-in. hot water meters for the boiler feed and a similar 6-in. cold water meter. The south pump

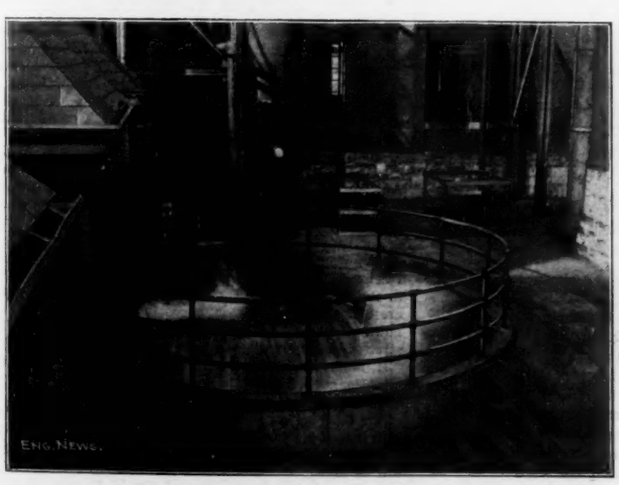


FIG. 5. HOT WELL.

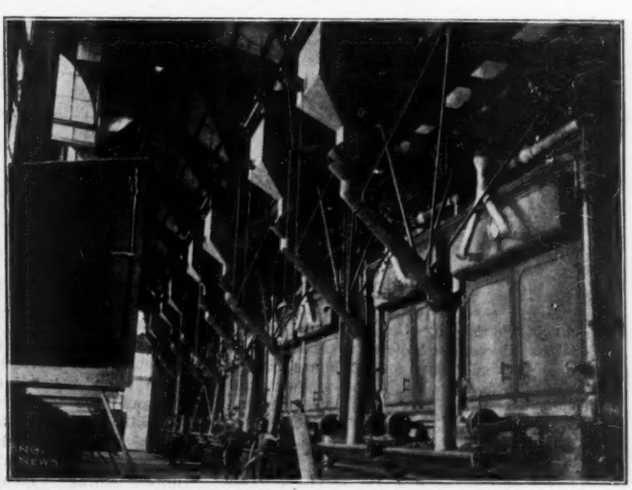


FIG. 6. NORTH BOILER ROOM (SHOWING COAL BINS AND WEIGHING HOPPERS).

room has the same number and size of meters, but they are of the Worthington piston type. The north room has four Excelsior heaters of 1,500 HP., while the south room has two of 2,500 HP. and two of 1,000 HP. The north side has eight Hoppes feed water purifiers, 68 ins. diameter and 26 ft. long, with a total of 8,000 HP. rated capacity, based on 30 lbs. evaporation per HP. per hour. Each purifier has 1,759 sq. ft. of lime catching surface. The south side has seven Hoppes purifiers of 750 HP. each. The main and auxiliary engines are all lubricated from a single stand, by the Siegrist automatic oiling system, which is provided with four 600-gallon Famous oil filters, two in each pump room. The steam piping is of extra heavy pipe, with cast-iron boxed flanges and pipe bends, and the Crane Co.'s extra heavy valves for live steam, and standard for lower pressures. The pipe work is drained by two Holly systems, one on each side of the station, and all low pressure drainage is taken care of by Bundy traps. All piping is covered with the H. W. Johns-Manville Co.'s asbestos sponge-felted sectional covering. Each engine has a Cochrane live steam separator.

COAL AND ASH HANDLING.—Near the east end of the north-side boiler house is a coal storage building of 3,500 tons capacity. Coal is delivered to the crusher house at the west end of the boiler room, and is carried by the conveyor over a series of bins above the boilers, these bins containing a supply sufficient for 12 hours run of each boiler. Under each bin is a 2-ton weighing hopper for weighing the coal used by each boiler. Fig. 6 shows the bins at the top, with the weighing hopper below, the latter having gates over the spouts leading to the grates. If the bins are full, the coal is carried on to the storage building, Fig. 7. This is of timber construction, the bins being made fireproof by a lining of concrete blocks or slabs, 12 × 26 ins., 3 ins. thick, with ship-lapped joints. The coal crushing plant has a capacity for crushing 35 to 40 tons of run-of-mine coal per hour. The same conveyor, returning underground, takes the ashes from the basement of the boiler room and deposits them in an elevated tank or bin between the crusher house and boiler house, from which they can be discharged into cars on a sidetrack.

The coal storage building on the south side of the station, Fig. 8, is 295 ft. 10 ins. long and 22 ft. 7 ins. wide, with storage capacity for 3,500 tons. It is parallel with the south boiler house. A crushing plant similar to that on the north side is provided. In the boiler house there are 14 weighing hoppers of 1 ton capacity, one to each boiler, each fitted with a Howe recording scale. The bins over the boilers are supplied by a conveyor 700 ft. long, with buckets 18×24 ins., driven by a double-cylinder steam engine. A separate ash conveyor, 648 ft. long, with buckets 18 × 18 ins., and operated by a Fairbanks vertical engine, carries the ashes from the ash pits to an elevated tank outside the building. Railway cars are run on a track alongside the tank and loaded by opening a chute at the side of the tank.

In the north coal storage house, Fig. 7, ventilation of the bins is provided by boxing in some of the posts and cross timbers to form vertical and horizontal trunks. Holes in the vertical trunks allow for the escape of gases generated by the coal, which pass out through holes in the walls at the ends of the horizontal trunks. In the south coal storage house, Fig. 8, the joists are in pairs, covered on the top, and pieces of 2-in. gas pipe lead from these trunks through the wall, as shown, to provide for ventilation. In this house the bunkers are double; ordinarily the coal is delivered into the upper part, marked "Bunker Storage," from which the coal is fed by gravity to the 1-ton hoppers above the boilers. When this part is full, the overflow falls through the trap at the back into the "Reserve Storage" below. When this reserve supply is required, the coal is discharged from the bottom into the coal conveyor, which elevates it to the top of the building again and discharges it into the "Bunker Storage" compartment, ready for the boilers.

The coal and ash conveyors are of the McCaslin overlapping gravity bucket type, and were put in by the John A. Mead Mfg. Co., of New York, N. Y. An exception, however, is the ash conveyor in the south boiler house, which is a steel bucket conveyor made by the Link Belt Co., of Chicago. For weighing the coal delivered at the station there are two 80-ton track scales, the one on the north side of the station being a Howe scale and the one on the south side a Fairbanks scale.

It will be noted that the water supply of the station and to the boilers is metered, and that the coal delivered to the stokers is weighed. It is intended that blanks should be filled out daily showing the consumption of fuel and water, which would be balanced daily with the watt-hour record of output, so as to keep a record of the daily economy of operation.

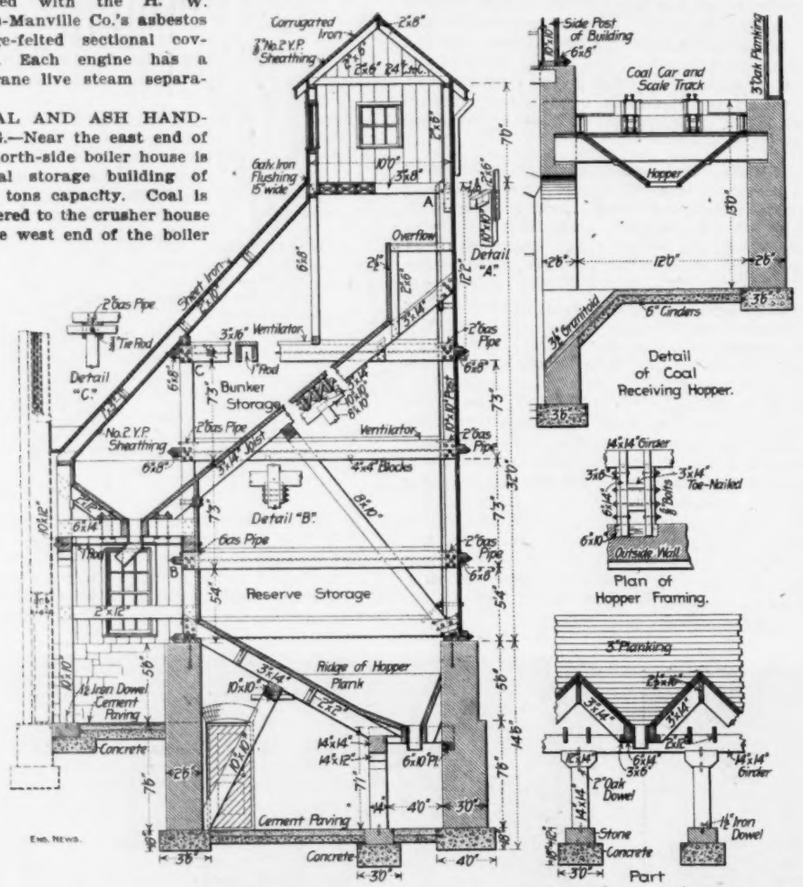


FIG. 8. SOUTH COAL STORAGE BUILDING (WITH DOUBLE BUNKERS).

AN ESTIMATE FOR REBUILDING THE AUSTIN DAM.

On March 24 a report and estimate was submitted to the Board of Water and Light Commissioners of Austin, Tex., on the cost of rebuilding the great dam across the Colorado River at that place, which failed two years ago. The report was made by Mr. W. F. Foster, of the contracting firm of Foster & Creighton, Nashville, Tenn., at the request of Mr. D. H. Coswell, Chairman of the committee appointed to investigate the cost of rebuilding the dam. We reprint those parts of the report of most interest, as follows:

Any estimate of this kind, in the absence of definite plans and specifications which are to be complied with, is at best uncertain and unsatisfactory.

The report herewith submitted is from the standpoint of a builder, guided by some experience in construction of similar work in other localities and from information obtained in your city as to various details of cost, and will therefore ignore technical questions as to cause and manner of failure, etc.

The engineering problems involved demand the most painstaking, careful investigation, and these you will doubtless submit to some member of that profession in whom you have entire confidence, and whose advice, plans and specifications, when once adopted, as well as his instructions with regard to details during the progress of the work, you will rigidly abide by. I may be pardoned for suggesting that some of the questions thus to be most carefully studied in the light of the unfortunate experience you have had are:

(1) Whether it will not be better to abandon entirely the present location, and in rebuilding adopt one by which you will avoid the "faults" or unreliable strata in the geological formation which seems to have been the prime cause of the trouble you have had, both with the foundation of the dam and the construction of your bulkhead masonry and power house. Of course, a large amount of material will be available by salvage from the old dam when removed, and from the debris from the portion destroyed.

(2) Whether, in view of the observed action of the overflow in time of flood, a modification of the profile or cross-section of your dam is not advisable, wherever it may be built, the up-stream face to be battered or offsetted in lieu of vertical, and the down-stream face to have flatter slope, thus increasing the weight of the mass and giving a larger frictional area upon the base.

(3) A careful consideration of the merits of the fossiliferous limestone, which is abundant in the vicinity of the dam, as a building material. It does not seem reasonable that stone which has withstood the action of the elements for untold ages should be condemned as altogether worthless. In view of the excessive cost of granite, both in quarry cost and transportation, as given to me in Austin, I believe that the limestone of the vicinity should be used in the up-stream face, at least to a point 14 ft. below the crest of the dam, and quite possibly on a portion of the down-stream face also, and that it will be reliable for strength and durability in that portion.

It might be assumed by some that inasmuch as the total length of the dam between abutments is 1,091 ft. and its total cost was about $611,000; and as about 91 ft. at the east end and 500 ft. at the west end, remain standing, that the interval of 500 ft. could be replaced for its pro rata of the total, or about $300,000. This supposition will be found erroneous for several reasons.

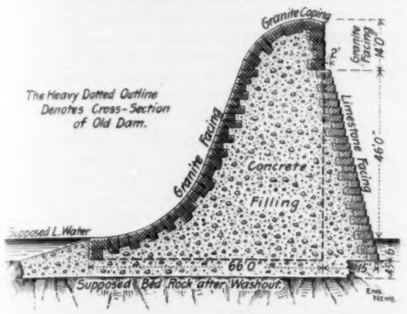
(1) The shattered condition of the 91 ft. now standing at the east end makes its removal and reconstruction a necessity, and inasmuch as this is at a place where a very troublesome leak occurred after completion of the dam, it is probable that the foundation itself ought to be excavated to greater depth.

(2) A large mass of the original dam is still standing just far enough down stream from its original position to be very much in the way of construction of new work, and must be removed.

(3) A very large deposit of earth and silt east of the present channel, also along the toe of the dam on the west

...ile of the channel, must be removed for construction of ...w work.

(4) An examination by sounding with an iron rod re...als the fact that the bedrock in the channel through ...hich the river is now flowing is an irregular surface ...nging from 8.6 to 12.6 ft. below the assumed low water ...ne, which was the top of the toe of the dam as built. ...is is the result of seven soundings, and is pretty con...lusive proof that not only the foundation stone is gone ...om this portion of the dam, but that the bedrock itself ...as been broken up and washed out to a depth in some ...aces of more than 6 ft. The average of these soundings ...10.8 ft., and while it is not certain that this condition ...tends to the eastern end of the gap, yet it will not be ...afe to estimate otherwise, as it is probable that if not



Proposed Section for Rebuilding the Austin Dam.
(Section of old dam has been added in dotted lines.)

washed out, at least that much would have to be removed before rebuilding. This break up of the bedrock I have assumed to be from a point 6 ft. above the upper face of the dam to a line 20 ft. below the toe. This, then, will make a pit 483 ft. long by 92 ft. wide by 4.8 ft. deep, which must be filled with masonry or concrete before reaching the base of the original dam.

(5) It seems to me imperatively necessary that the toe of the dam its entire length should be protected by an apron of masonry or concrete to prevent undermining. This I have estimated as 1,100 ft. long, average width 20 ft., average depth 3 ft.

(6) In my estimate I assumed that the up-stream face-wall will be built of limestone to a height 14 ft. below the crest of the dam, and will have a slope or batter of 3 ins. to 1 ft. vertical. This will add 442 sq. ft. to the original sectional area of the dam making it 2,642 sq. ft. The upper 14 ft. of the up-stream face, the coping, and the down-stream face all to be of granite as in original plans. All this will be shown more fully by the sketch which I herewith enclose showing suggested profile. It is suggested that the entire filling or interior shall consist of concrete made of American Portland cement.

(7) The cost of the contractor's plant or outfit under conditions like these is qutie as great for the construction of a dam 600 ft. long as for the original length of 1,091 ft.

With the above explanations, I submit the following estimate of cost:

Earth excavation, wet and dry, 21,000 cu. yds., at 30 cts., $6,300.
Rock excavation, 2,000 cu. yds., at $1.60, $3,200.
Removal of masonry now standing, 14,000 cu. yds., at $1, $14,000.
Granite coping course, 1,373 cu. yds., at $19, $26,087.
Granite facing, down stream, 5,535 cu. yds., at $11.75, $66,036.25.
Granite facing, up stream, 684 cu. yds., at $11.50, $7,866.
Coursed limestone masonry, up-stream face, 4,738 cu. yds., at $7.50, $35,535.
Concrete filling, 55,749 cu. yds., at $5.50, $306,619.50.
Total, $464,643.75.
Deduct for salvage of granite in old dam and debris, 3,025 yds., at $7, $21,175.
Total net, $443,468.75.

In the above estimate it is assumed that the granite work can be done at the same prices as in the original contract, notwithstanding the increased figures given now when in Austin. It is also assumed that all the work will be laid in American Portland cement mortar of approved quality.

In this report I have made no attempt to determine the extent or estimate the cost of work to be done in reconstruction of the power house. Whether the headgate masonry must be rebuilt; whether the penstocks and turbines should be lowered; whether two or three penstocks will not be sufficient in lieu of six, and whether the river wall of the power house should be more solidly rebuilt, are questions that can be best decided by those who are familiar with all the details, and who know the present condition of the plant and the cost of all the items involved.

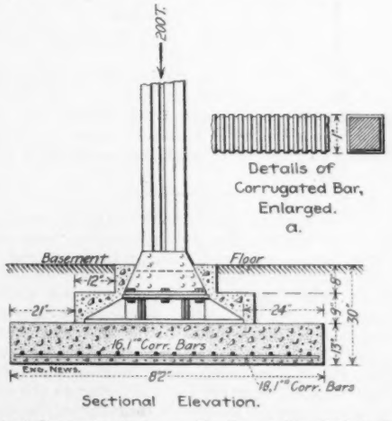
One detail, however, should not be overlooked or neglected in any event. The tail race by which water is discharged from the turbines should be so directed that the current will not scour along the toe of the dam, thus endangering its stability, however carefully it may be protected.

A NEW FORM OF CONCRETE-STEEL COLUMN FOOTING.

We illustrate in the accompanying cut a column footing of steel-concrete construction which has been employed in several contracts by the St. Louis Expanded Metal Co., of St. Louis, Mo., and for which a number of advantages are claimed. As will be seen, the footing consists of a flat block of concrete having embedded in its lower half a grillage or grill-work of corrugated steel bars of the form shown at a in the drawing. The bars are made in various sizes, from ¼-in. to 2 ins. square. As an indication of the economy of the construction, the company compares the footing illustrated with one made up of concrete blocks, without embedded metal, and obtains the following costs: Steel-concrete footing, $51.51; plain concrete footing, $61.25. The argument in favor of the new footing prepared by Mr. A. L. Johnson, M. Am. Soc. C. E., the engineer of the company, is as follows:

NECESSITY OF CORRUGATING.—By scientific tests made abroad by M. Considére, Engineer Bridges and Roads, Paris Department, as well as by tests made by ourselves, both in practice and in the laboratory, it has been determined that the adhesion between concrete and metal is likely to be destroyed in the course of time through vibrations and shocks, to which all structures are more or less subjected. This being the case it becomes at once necessary to use such bars for this re-enforcement as have a mechanical form of bond which cannot be destroyed. The ideal arrangement would be a bar having square shouldered wings projecting from all sides of the bar, the sides of these ribs being at right angles to the axis. Such a bar, however, could not be rolled, and cast bars of this character would have very little strength. Fortunately, however, it is not necessary that the sides of these ribs be exactly at right angles to the axis of he bar, owing to the friction between the materials used, and the theoretical condition is that the sides of the ribs may depart from this plane at right angles to the axis by an amount equal to or less than the angle of friction between these materials, which for concrete and metal amounts to about 24°. This principle makes it practicable to roll a bar having ribs, the sides of which will fulfil the necessary condition. This has been accomplished in our corrugated bar, and the patent on same covers all bars which can be rolled, in which the slope of the side of the ribs departs from the plane at right angles to the axis by an amount equal to or less than the angle of friction.

COMPARISON IN RELIABILITY WITH BEAM RE-ENFORCEMENT.—Construction employing beams for concrete re-enforcement, whether in the nature of foundations, or as in the Melan construction, for arch bridges, is open to serious objection as to the lasting qualities of such structures. The reason for this is that the concrete and beams cannot be made to act together. It is impossible to get enough concrete around the flange of an I-



Sectional Elevation.

Steel-Concrete Column Footing with Rolled Corrugated Bars.
St. Louis Expanded Metal Co., St. Louis, Mo., Builders.

beam so that the adhesion, even supposing that this would remain permanent, would be sufficient to develop the full tensile strength of the flange. That is to say, the ratio of the perimeter to the cross-sectional area is not sufficient for this purpose. The same amount of metal in the form of small bars more uniformly distributed through the section, would be compelled to move in unison with the concrete, so that even on the basis of perfect adhesion in both cases, if the structure is subject to any deflection the steel and metal will not act together, and in the course of time a cleavage plane will be formed around the beam. When this occurs a very slight deflection will crack the unassisted concrete, and these cracks may lead to the ultimate destruction of the steel work. As a matter of fact, the adhesion cannot be depended upon, and to a much greater extent, therefore, is this really the case. By the use of the corrugated bars, which will not slip in the concrete, the concrete is prevented from cracking, and the construction is permanent.

FLEXIBILITY.—The tests made by M. Considère have also shown that concrete, when properly re-enforced by metal well diffused throughout the section, is capable of taking elongations amounting to 20 times as much as it is capable of in an unre-enforced state, without cracking, and without seriously impairing its full tensile strength. This has been demonstrated by very careful scientific experiments, and we have noted the same sort of thing in tests made on our floor constructions, where relatively high deflections have occurred, amounting to many times what the concrete could have withstood if no metal had been used, namely, that no cracks were perceptible, even on a perfectly smooth surface. This proposition, we think, can be considered as having been thoroughly demonstrated, and it has an enormous influence on the security and adaptability of steel-concrete structures where the re-enforcement is properly distributed as above described. It makes it possible, for example, to build masonry structures on pile foundations, rather than solid rock, without running risk of having cracks in the structure. It also enables the distortions resulting from temperature stresses and shrinkage to be taken up with no injurious effect.

THE LATEST PERPETUAL MOTION INVENTOR hails from Chicago, and the "Chronicle" of that city devotes a column to his "discovery." This is, in brief, that there is a "natural draft" in every tall chimney or other stack, independent of any furnace or other source of heat at its base, and this the inventor utilizes to drive a windmill. The "qualitative analysis" of this inventor is not so bad, but when it comes to the "quantitative" he is a little weak. He proposes to build a steel stack 1,050 ft. high and estimates the power obtainable from it at 50 HP., which he thinks should be sufficient for lighting the St. Louis fair! Only a Chicago paper would be so unkind as to print such an item regarding St. Louis' enterprise.

THE MEDITERRANEAN-BAY OF BISCAY SHIP CANAL project has been again before the Committee on Maritime Affairs of the French Chamber of Deputies. The chairman of this committee recommends the construction of the canal for strategical as well as commercial reasons, as it would destroy the importance of Gibraltar. As now proposed the canal would be 280 miles long; have 27 locks, possibly fitted with elevators capable of lifting vessels of 1,000 tons 50 ft., and the estimated total cost is $263,000,000; or, $305,000,000 including naval constructions and fortifications at Arcachon and Narbonne. The time of transit is put at 42 hours, and the annual cost of maintenance at $2,000,000. Notwithstanding the quoted elevator locks of 1,000 tons capacity, the promoters figure upon steamers of 3,000 tons using the canal—probably by ordinary locks. The committee figures upon 25,000,000 tons of ocean traffic and 3,000,000 tons of coast traffic, or half the traffic now using Gibraltar, and at a uniform rate of 35 cts. per ton it expects an annual revenue of $9,800,000. An elaborate table of distance saved by the proposed canal accompanies the report. From Havre to Marseilles the saving would be 1,010 miles, the most favorable showing; from Liverpool to Marseilles the distance saved would be 976 miles; to Malta, 667 miles; to Barcelona, 770 miles, etc.

SIAMESE RAILWAY CONSTRUCTION, says U. S. Consul-General Hamilton King, of Bangkok, commenced about ten years ago, and resulted in the completion—in 1893, of the 16.7-mile line connecting Bangkok and Paknam, at the mouth of the River Menam. This road is under Danish control and has a capital of $150,000; it now pays about 7% on the investment. In 1892, the Government commenced the railway connecting Bangkok with Korat—102.5 miles apart, running northeast from the capital. This road was opened in December, 1900, and has cost much money and life. It is of the type of the cheaper light traffic roads. From a point 57.1 miles from Bangkok, the Lopburi line branches to the north and is now completed 26.1 miles to the city of Lopburi; it is to be extended eventually to Chiengmai, a distance of 372.8 miles, and construction has been commenced. The surveys are completed and building commenced on a railway that will run southeast from Bangkok—94.4 miles—to Pechaburee, and it is expected that this line will be completed by January, 1903. Another Government line is proposed running from Bangkok east and south to Srimaharacha, on the coast, and 87 miles distant. Besides these two private railway concessions have been recently granted to Siamese. One from Taurua, on the Lopburi line, to Prabat, 10.5 miles; the other from Bangkok to the mouth of the Tatian River. In ten years the Government has expended $8,000,000 gold on its railways; and they are paying about 1% on this investment. The management and financing are poor.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston. } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; *6 months,* $2.50; *2 months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.00 (31 *shillings*); *Thin Paper Edition, One Year,* $6.31 (26 *shillings*). *SINGLE COPIES of any number in current Volume,* 15 *cents.*

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 322 *means that subscription is paid to the* 32d *week (that is the issue of Aug.* 7) *of the year* 1902; *the change of these figures is the only receipt, unless one is sent by special request.*

ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

In connection with our first description of the water-power plant at Massena, N. Y., in our issue of Dec. 16, 1897, we pointed out that the company's financial success would hinge largely on the possibility of marketing its power after it was developed; and that it was likely to have great difficulty in doing this. In confirmation of our prediction, it is now announced that the St. Lawrence Power Co., which has built and owns the plant, is to be reorganized, foreclosure proceedings being undertaken on behalf of the bondholders. The water-power plant, which was fully described in our issue of Feb. 21, 1901, is capable of furnishing about 35,000 HP., and can be enlarged by a comparatively small investment to double this capacity. Practically the only chance for marketing this is through the establishment of local manufacturing plants, and it requires extreme inducements for any such enterprises to locate at a point so remote from markets. There are only two classes of industries in which the cost of power is so large an item that they can afford to even consider such a location. These are the electro-chemical industry and the paper industry. The very large number of huge water-power plants which have been built during the past few years, however, has given the purchasers of power for use in these industries plenty of choice; and Massena power must be sold at a very low figure indeed to counterbalance the advantages of central location and convenient transportation which other water-power plants can offer.

In our issue of March 20, we said that "the chances of the passage of a canal bill in the New York legislature appears to be about evenly balanced, with the scale turning if anything against the measure." Shortly afterward the turning of the scale became decisive, and the legislature finally adjourned on March 27 without action on the canal bills.

In view of our past editorial expressions on this subject, we hardly need to add that this outcome is extremely fortunate for all parties concerned. New York should either spend no money at all on its canals beyond that necessary to maintain them in their present condition, or else it should spend enough to build the 1,000-ton barge canal recommended by the Canal Advisory Commission of 1899, and to build it on the route where it can be most economically constructed.

But when the state is ready to spend such a sum on its canals it should first offer this sum to Congress as a contribution toward the cost of a 21-ft. deep waterway to be built by the Government from the Lakes to the Atlantic. It may be said that New York voters would never approve such a contribution; but there are good reasons why such a scheme should meet with popular favor. It must be remembered that the taxpayers of the state have now to pay about a million and a-half dollars every year to maintain and operate the present obsolete canals. If these canals were turned over to the Federal Government, this burden would be lifted. Hence, apart from the benefits to be gained by the state from the construction of a ship canal across it, and the expenditure of $200,000,000 within its borders, the taxpayers could afford to contribute $50,000,000 toward such a canal, and the interest on the debt would amount to no more than the cost of maintaining and operating the present state canals.

As our readers will recall, we made a similar suggestion in our issue of Jan. 16, for the building of a deep waterway from the Lakes to tidewater by joint contributions from the state and national treasuries. The comments made on this suggestion by some of our newspaper contemporaries were highly interesting. The Baltimore "Sun" thought that the National Government would be very slow to contribute its share, because the construction of such a waterway would help New York city to maintain its commercial supremacy. The Washington "Post" was sure New York would not be so foolish as to aid in the construction of a canal which would permit shipping to sail direct from Lake ports to Europe without stopping. It said:

> As Engineering News is a New York publication, we are quite at a loss for an explanation of its position in this matter. Perhaps it is so broadly patriotic and so comprehensively altruistic that it is ready to sacrifice the metropolis to the general welfare. Perhaps, too, it has such boundless confidence in the benevolence and self-sacrificing spirit of New Yorkers that it believes them possessed of a yearning desire to pay $50,000,000 for a work that would be of vast advantage to America and Europe, notwithstanding the fact that its completion would strike the knell of New York's export trade.

Finally, the Pittsburg "Dispatch" ridiculed the idea that ocean-going vessels would use such a canal at all, and expressed the opinion that the 1,000-ton barge canal would be quite as advantageous to New York as the proposed 21-ft. deep waterway.

The symposium reminds one of the old story of the blind men and the elephant, where "each was partly in the right and all were in the wrong."

It is probably true that ocean-going steamers would make very little use of a canal to the Lakes. Indeed, the channel proposed by the Deep Waterway Commission would only accommodate the smaller class of ocean vessels. On the other hand, the deep waterway can do what the barge canal cannot—bring the Lake shipping to the seaboard, instead of leaving it tied up in the harbors during five months out of the twelve. This would benefit all the cities of the Atlantic seaboard and not New York alone. Baltimore and Philadelphia, and the other ports which rival New York can well afford to look to the benefits they are to receive rather than to the chance that their rivals will gain something.

The suggestion which interests us most, however, is the assumption of the Washington "Post" that because Engineering News is a New York publication, its editorial opinions are molded to what will benefit the local interests of New York city. Our readers, we are sure, better understand the principles and policy of this journal. The fact that our publication offices are located in New York is no reason whatever why we should favor local interests in the discussion of matters like these. Our circulation is national and international, and it would be absurd for us to look at questions involving local interests or commercial rivalries from any other standpoint than "the greatest good to the greatest number."

We called attention two weeks ago to the confusion and trouble which would result in many Government departments if the bill compelling the metric system to be used in all Government transactions were to become a law. We are informed that a formal protest against the measure has been submitted by Admiral Bowles, Chief Naval Constructor, in which he states that it would be practically impossible to employ the metric system in the work of his bureau in advance of its general adoption throughout the country.

Within the past few years a number of municipalities in this country have established all-the-year-round municipal bath-houses, while others have added to the number of open bathing or swimming places, which, for some years past, have been maintained during the summer months. Information collected for our forthcoming "Municipal Year Book" shows that 36 cities and towns with 3,000 population and upwards, by the U. S. Census of 1900, now have either all-the-year or summer public baths. These places are as follows: Boston, Brookline, Cambridge, Dedham, Holyoke, Newburyport, Quincy, Springfield, Watertown, Worcester, Mass.; Providence, R. I.; Hartford, Conn.; Albany, Buffalo, New York, Rochester, Syracuse, Troy, Utica, N. Y.; Hoboken, Newark, N. J.; Homestead, Philadelphia, Pa.; Wilmington, Del.; Baltimore, Md.; Greenwood, S. C.; Newnan, Savannah, Ga.; Cleveland, O.; Muskegon, Mich.; Chicago, Ill.; Milwaukee, Wis.; Des Moines, Ia.; Crookston, St. Paul, Minn.; San Jose, Cal.

The 36 places in question are distributed over 16 states, but Massachusetts has 10 and New York 7 of these cities and towns. Most of the other states are represented by one municipality, only. Outside of the states of Massachusetts and New York most of the public baths are open only in the summer, and that is true of some of the places in Massachusetts. It is known that Newark, Chicago and St. Paul have all-the-year bath-houses.

In 1895, the legislature of New York passed an act which permits any municipality of that state to establish all-the-year baths, and makes it compulsory for cities of 50,000 inhabitants and over to do so.

Municipal baths, often combined with public wash-houses or laundries, are becoming more and more common in England, and the signs of the times are that they will rapidly gain popular favor in this country. The laundry feature will, naturally, gain ground much more slowly than the baths. Thus far it has not been introduced in the United States further than to make provision for washing the personal clothing of the bathers. Drying closets are also provided, so an unfortunate man with no change of clothing may be ensured of clean underclothes to put on after his bath.

A bill has been introduced into Congress requiring railways after a certain time to have all their cars equipped with air-brake hose-couplings, which will couple automatically by impact, and also requiring all car couplings applied to new cars or used in repairs to be capable of automatic operation on a curve of a certain radius. There is probably little chance that the bill will become a law, and it certainly ought not to be enacted. Automatic hose-coupling devices have not yet reached such a state of perfection, so far as we are aware, that their compulsory use would be justified. As for the requirement of flexibility in car couplings, the railways themselves are perfectly competent to take care of the matter, and can do so more effectively without compulsory legislation, we believe, than with it.

All trains passing through the Park Ave. tunnel of the New York Central R. R. in New York city must be operated by electricity after May 1,

1905, according to the terms of a bill passed in the closing hours of the New York legislature. As already recorded in these columns, the company desired to substitute electric traction for steam locomotives on its suburban trains only, and to continue the use of steam locomotives on the through trains, hauling them through the central tunnel, which has ventilating openings in its roof. The public, however, with the memory of the rear-collision of last January fresh in mind, would hear of nothing but electricity throughout, and the New York Central officials will have to cope with the task of handling the entire traffic between the Harlem River and the Grand Central station with electric power. Probably motor cars will be used on the suburban trains and electric locomotives for the through trains, although it is possible that under the new conditions electric locomotives may be used for both. In either case a stop for a change to steam locomotives must be made at some point north of the Harlem. The question where to locate a yard for making such a change is one of a good deal of importance. It would, perhaps, be possible at present to locate it at Mott Haven, just north of the Harlem, but that would necessitate stopping every suburban train for a change of motive power. Besides this, the country north of the Harlem is rapidly filling up with population, and it is easy to foresee a time when steam locomotives will be complained of in this district as they now are south of the Harlem. It seems to us probable, therefore, that the company will conclude to extend its third-rail system at least as far north as Kingsbridge on its own main line, to Yonkers and to Ardsley on its Putnam division, and to Mount Vernon on its Harlem line. The New Haven company will be apt to do the same thing as far as New Rochelle. Such a system would enable the companies to give a frequent electric service for the suburban territory covered by the third-rail system, which would include that furnishing the bulk of the suburban traffic. For trains running north of these points, either a change of cars or a change of motive power would be necessary; but the number of such trains is not so large but that the change of motive power could be made without great difficulty.

Should electric traction be carried out on the scale above indicated, it will be far and away the most extensive piece of work in the substitution of electric motive power for steam locomotives ever undertaken.

SEWAGE PURIFICATION AND WATER POLLUTION IN THE UNITED STATES.

The present extent of sewage purification in the United States is partly shown by the accompanying list of 95 cities and towns of 3,000 population and upwards where some means of treating the sewage is practiced. About nine years ago a series of articles on "Sewage Purifi-

TABLE I.—SEWAGE PURIFICATION IN PLACES OF 5,000 POPULATION AND UPWARDS BY THE U. S. CENSUS OF 1900.

Towns or cities.	Population.	Manner of purification.
Amherst, Mass.	5 028	Sedimentation.
Andover, Mass.	6,813	Septic tank and intermittent filtration.
Brockton, Mass.	40,063	Intermittent filtration.
Clinton, Mass.	13,607	Intermittent filtration.
Concord, Mass.	5,652	Intermittent filtration.
Framingham, Mass.	11,302	Broad irrigation and intermittent filtration.
Franklin, Mass.	5,017	Intermittent filtration.
Gardner, Mass.	10,813	Intermittent filtration.
Leicester, Mass.	3,416	Intermittent filtration.
Marlboro, Mass.	13,609	Intermittent filtration.
Natick, Mass.	9,488	Intermittent filtration.
North Brookfield, Mass.	4,587	Broad irrigation.
Southbridge, Mass.	10,025	Intermittent filtration.
Spencer, Mass.	7,627	Intermittent filtration.
Westboro, Mass.	5,400	Intermittent filtration.
Worcester, Mass.	118,421	Chemical precipitation; intermittent filtrat'n
Central Falls, R. I.	18,167	Sedimentation and intermittent filtration.
Pawtucket, R. I.	39,231	Intermittent filtration (part of sewage only).
Providence, R. I.	175,597	Chemical precipitation.
Woonsocket, R. I.	28,204	Intermittent filtration.
Bristol, Conn.	6,268	Intermittent filtration.
Danbury, Conn.	16,537	Intermittent filtration.
Manchester, Conn.	10,601	Intermittent filtration.
Meriden, Conn.	24,296	Intermittent filtration.
Depew, N. Y.	3,379	Chemical precipitation.
Kingston, N. Y.	24 535	Septic tank; contact beds (part sewage only)
New Rochelle, N. Y.	14,720	Chemical precipitation.
New York, N. Y.	3,437,202	Chemical precipitation (for part sewage only)
White Plains, N. Y.	7,899	Chemical precipitation.
Burlington, N. J.	7,392	Filtered.
Long Branch, N. J.	8,872	Strained.
Plainfield, N. J.	15,369	Intermitten filtration; septic tank and contact beds.
Princeton, N. J.	3,899	Broad irrigation.
Summit, N. J.	5,302	Intermittent filtration.
Vineland, N. J.	4,370	Filter beds.
Altoona, Pa.	38,973	Intermittent filtration (for part sewage only)
Reading, Pa.	78,961	Double sand filtration.
Wilmington, N. C.	20,976	Not given.
Aiken, S. C.	3,414	Filter beds.
Danville, Ky.	4,285	Septic tank, bacteria beds.
Alliance, O.	8,974	Chemical precipitation.
Canton, O.	30,667	Chemical precipitation.
Delaware, O.	7,940	Septic tank and contact beds.
Fostoria, O.	7,730	Land disposal.
Glenville, O.	5,588	Chemical precipitation; coke and sand filtrs.
Kenton, O.	6,852	Not given.
Lakewood, O.	3,355	Septic tank and filter beds.
Mansfield, O.	17,640	Septic tank, and bacteria beds.
Oberlin, O.	4,082	Intermittent filtration and broad irrigation.
Shelby, O.	4,685	Filtered.
Holland, Mich.	7,790	Septic tank; coke strainer.
Red Jacket, Mich.	4,668	On old farm.
Saint Johns, Mich.	3,388	Sewage farm.
Champaign, Ill.	9,098	Septic tank.
Kewanee, Ill.	8,382	Septic tank.
La Grange, Ill.	3,969	Septic tank.
Macomb, Ill.	5,375	Septic tank.
Mendota, Ill.	3,736	Intermittent filtration.
Monmouth, Ill.	7,460	Not given.
Murphysboro, Ill.	6,463	Not given.
Paris, Ill.	6,105	Sedimentation.
Princeton, Ill.	4,023	Septic tank, sand filter.
Urbana, Ill.	5,728	Septic tank.
Fond du Lac, Wis.	15,110	Septic tank; contact beds.
Madison Wis.	19,164	Septic tank; filter beds.
Ripon, Wis.	3,818	Intermittent filtration.
Waukesha, Wis.	7,419	Septic tank; sand filters.
Marion, Ia.	4,102	Septic tank.
Marshalltown, Ia.	11,544	Septic tank; contact beds.
Hastings, Neb.	7,188	Sewage farm.
Brookfield, Mo.	5,484	Series of ditches.
Columbia, Mo.	5,651	On open field.
Independence, Mo.	6,974	Septic tank; filter beds.
Houston, Tex.	44,633	Intermittent filtration.
McKinney, Tex.	4,342	Sewage farm.
Paris, Tex.	9,358	Intermittent filtration.
Sherman, Tex.	10,243	Broad irrigation.
Temple, Tex.	7,065	Sewage farm (not in use).
Boulder, Colo.	6,150	Settling pond.
Colorado Springs, Colo.	21,085	Irrigation.
Greeley, Colo.	3,023	Irrigation.
Leadville, Colo.	12,455	Strained.
Trinidad, Colo.	5,345	Sedimentation.
Raton, N. Mex.	3,540	Irrigation.
Walla Walla, Wash.	10,049	Irrigation (for part sewage only).
Bakersfield, Cal.	4,836	Irrigation.
Los Angeles, Cal.	102,479	Irrigation (for part of sewage only).
Pasadena, Cal.	9,117	Irrigation.
Pomona, Cal.	5,526	Septic tank; broad irrigation.
Redlands, Cal.	4,797	Irrigation.
San Luis Obispo, Cal.	3,021	Septic tank.
Santa Rosa, Cal.	6,673	Chemical precipitation and broad irrigation.
Visalia, Cal.	3,085	Broad irrigation.
Phoenix, Ariz.	5,544	Broad irrigation.
Tucson, Ariz.	7,531	Irrigation.
Salt Lake City, Utah.	53,531	Broad irrigation.

TABLE II.—CLASSIFIED SUMMARY OF SEWAGE PURIFICATION PLANTS IN THE UNITED STATES IN PLACES OF 3,000 POPULATION AND UPWARDS.

Intermittent filtration	24	Chemical precipitation:	
And broad irrigation	2	And broad irrigation	1
And sedimentation	1	" coke and sand filtration	1
	27		10
Broad irrigation & sewage farm'g*	9	Filtered	4
Irrigation in the West	8	Sedimentation	4
Land disposal	4	Strained	2
	21	Double sand filtration	1
Septic tanks	7	Method not given	4
And contact beds†	8		
" bacteria beds	2	Total	95
" intermittent filtration	3		
" broad irrigation	1		
" coke strainer	1		
	22		
Chemical precipitation	7		
And intermittent filtration	1		

*Including a sewage farm at Temple, Tex., not in use at present.
†Intermittent filtration is also used at Plainfield, N. J., for a portion of the sewage.

TABLE III.—WATER POLLUTION IN PLACES OF 3,000 POPULATION AND UPWARDS BY THE U. S. CENSUS OF 1900.

Cities.	Population, 1900.	Result of Suit.
St. Albans, Vt.	6,239	Lost.
Fitchburg, Mass.	31,531	Pending.
Worcester, Mass.	118,421	Compelled to extend purification works.
Danbury, Conn.	16,537	Ordered to purify sewage.
Meriden, Conn.	25,908	Lost several suits.
Naugatuck, Conn.	10,541	Suits threatened.
New Britain, Conn.	25,908	Lost.
Stanford, Conn.	15,997	Adjusted by agreement.
Waterbury, Conn.	45,859	Lost.
Auburn, N. Y.	30,345	Discontinued before trial.
Ballston Spa, N. Y.	3,923	One suit lost; 30 suits pending.
Gloversville, N. Y.	18,349	One suit lost (judgment of $100); other suits pending.
Johnstown, N. Y.	10,130	Forty-four suits settled for $13,500.
Middletown, N. Y.	14,520	Stream condemned for sewerage purposes.
Rochester, N. Y.	162,608	Water pollution cases successfully defended by city; claims for damages for storm water overflow paid.
Saratoga Spgs, N. Y.	12,409	Lost one suit; settled others. Ordered by State Board of Health to remove sewage from creek.
Passaic, N. J.	27,777	City won injunction suit.
Paterson, N. J.	105,171	Court decided city could not be enjoined, but that riparian owners can sue for damages.
Summit, N. J.	5,302	City won suit brought to enjoin discharge of effluent from intermittent filter beds into river.
Altoona, Pa.	38,973	Lost; $600 damages; sewage from one district is now purified—not stated whether this was result of suit.
Danville, Pa.	8,042	Lost.
Old Forge, Pa.	5,630	Won.
Rankin, Pa.	3,775	Non-suit.
Washington, Pa.	7,670	City ordered to dispose of sewage in some other way.
Charlotte, N. C.	18,091	Two suits pending.
Gastonia, N. C.	4,610	Compromised.
Raleigh, N. C.	13,643	Won.
Washington, Ga.	3,300	Lost; paid $150.
Waycross, Ga.	5,919	Pending.
Birmingham, Ala.	38,415	Lost.
Ashtabula, O.	12,949	Pending.
Bowling Green, O.	5,067	Two suits settled.
Cleveland, O.	381,768	Lost; injunction granted.
Columbus, O.	125,560	Pending.
Mansfield, O.	17,640	Lost.
Marion, O.	11,862	Lost; $500 damages.
Norwalk, O.	7,074	One suit lost; others pending.
Norwood, O.	6,480	Pending.
Oberlin, O.	4,082	Plaintiff withdrew suit on account of sewage farm before trial.
St. Johns, Mich.	3,388	Lost; before establishment of sewage farm.
Bloomington, Ill.	23,286	Won one suit for stench and overflow damages and compromised others.
La Grange, Ill.	3,969	Dismissed without prejudice.
Macomb, Ill.	5,375	Settled; city put in septic tank.
Monmouth, Ill.	7,460	Settled.
Ashland, Wis	13,074	Won.
Fond du Lac, Wis.	15,110	Suit dismissed.
Waukesha, Wis.	7,419	Lost.
Creston, Ia.	7,752	Pending.
Marion, Ia.	4,102	Lost; before septic tank was built.
Marshalltown, Ia.	11,540	City enjoined.
Fremont, Neb.	7,241	Won.
York, Neb.	5,132	Won in District Court; pending on appeal in Supreme Court.
Kirksville, Mo.	5,966	Lost.
Moberly, Mo.	8,012	Settled; city extended outlet.
Sedalia, Mo.	15,231	Pending.
Texarkana, Ark.	4,914	Won $10,000 suit; $25,000 suit pending.
Hillsboro, Tex.	5,346	Dismissed for want of proof.
Paris, Tex.	9,358	Won.
San Antonio, Tex.	53,321	Several suits lost; others pending.
Temple, Tex.	7,065	Company enjoined from discharging effluent from sewage farm into stream; discontinued use of sewers
Texarkana, Tex.	5,256	See Texarkana, Ark.
Trinidad, Colo.	5,345	Lost.
Eugene, Ore	3,236	Won.
Oakland, Cal.	66,960	Lost.
San Luis Obispo, Cal	3,021	Suits brought prior to installing septic tank.
Santa Rosa, Cal.	6,673	Lost; $5,000 damages.
Prescott, Ariz.	3,559	Won.
Salt Lake City, Utah.	53,531	Won.

cation in America," which had been published in Engineering News, was brought together in book form. Only 31 cities and towns in the United States, large and small, had established sewage purification works at that time (early in 1893). The present list includes no plants in places of less than 3,000 inhabitants, so the increase in the number has been even more than appears from the accompanying table. At each period a number of makeshift plants were included which but slightly lessened the nuisance that might result if the sewage were finally discharged in its crude state. The list for each period includes, also, a number of Western towns where a part or all the sewage is utilized for irrigation, and not treated from sanitary motives.

Table I. gives the names and populations of the places which at the beginning of 1902 had more or less efficient sewage purification works, and also the method used for disposal. Both the list of places and the classification of methods employed is based primarily upon reports from city officials made for use in "The Municipal Year Book," but many of these reports have been supplemented by special information collected by Engineering News during the past ten years. As it is very desirable to make the list complete and correct, notices of errors or omissions will be welcome.

The method of sewage purification which at the outset gained the strongest foothold in the United States was intermittent filtration. Table II. shows that this is still far in the lead, numbering 24 cities and towns, against 9 for broad irrigation and sewage farming, and 7 each for septic tanks and chemical precipitation. If the western irrigation plants were included with broad irrigation and sewage farming, as there is good reason to do in several instances, and some ground for doing in each case, the septic tanks and chemical precipitation plants would each be outnumbered.

The seven places thus far mentioned are by no means the only ones in which the septic tank has been installed. In 15 other cities and towns the septic tank is combined with other methods of treatment, but counting all places where this method is used either singly or in combination gives only 22 municipalities which have septic tanks, against 24 which use intermittent filtration alone, and 27 which combine the latter process with either broad irrigation or sedimentation. Then, too, three of the cities using septic tanks combine that method with intermittent filtration, but are not counted in the intermittent filtration list.

Chemical precipitation never made much headway in this country, and of late it has been almost at a standstill. True, the city of Providence has recently put in operation the largest chemical precipitation plant on this side of the Atlantic, but the process was adopted years ago as a part of an improved sewerage system. Meanwhile our knowledge of the nature of that and other processes of treatment, and their applicability to American conditions, has greatly increased. Some method of disposal on land, with more or less preparation of the disposal area, had become pretty well established as the American practice until the introduction, a few years ago, of the septic tank and contact or bacteria beds. Already the number of cities and towns which use septic tanks, alone or combined with other treatment, is nearly as great as the total number of works for the purification, or partial purification, of sewage in 1893. Perhaps the number would be quite as large if the tables here given included places of less than 3,000 inhabitants.

All the contact and bacteria beds reported for "The Municipal Year Book" receive sewage from septic tanks. In general, it may be stated that the septic tank is comparable, both in work accomplished and possible combination with other modes of treatment, with chemical precipitation, but is more popular than the latter because it entails no expense for chemicals, and, it is claimed, comparatively little labor or expense for sludge disposal. But for the most part, conservative engineers believe that the septic tank has gained its foothold in this country through faith rather than by works. In other words, it was quite widely adopted while still in the experimental stage, if indeed it has yet passed beyond that stage. The same is yet more true of contact and bacteria beds, so far as they have come into use in the United States, but it is notable that these are reported from but 10 municipalities, against septic tanks from 22. Notwithstanding what has just been said, it now appears that the septic tank is worthy of a large part of the confidence which has been placed in it, and is certain to continue to be a feature of sewage disposal in the United States. The contact and bacteria beds cannot be spoken of with so much confidence, but undoubtedly some system of treatment at a higher rate per acre than is possible with intermittent filtration will gradually be established in localities where sandy soil, fitted by nature for the cheap construction of intermittent filters, is not available.

The second group in Table II. is not so significant in its relation to the sewage purification problem as might be inferred from the fact that it includes a total of 22 cities and towns. The nine places classed as practicing broad irrigation and sewage farming may be given fair weight, but most of the balance are either more or less in the nature of makeshifts, or else the chief object is the utilization of the sewage water for irrigation.

A careful examination of the whole list of 95 places, in the light of the relatively small amount of evidence given in the reports for "The Municipal Year Book," supplemented by more detailed information elsewhere available, indicates that, say, sixty places in the United States of 3,000 population and over have really creditable sewage purification plants. The number is increasing rapidly, and within a very few years will doubtless reach one hundred.

That such an increase is inevitable is evident from the information given in Table III., which relates to water pollution suits. The blanks used in collecting information for "The Municipal Year Book" contained these two questions: "Has the city had to defend any lawsuits for the pollution of water by its sewage?" "If so, with what result?" A total of 66 cities and towns reported suits, either past or pending, and one reported that suits were threatened. The results of the suits, as reported from 66 places, may be broadly summarized as follows: The cities lost in 29 instances, won in 15, and 7 of them compromised the suits; 5 reports stated that the suits were discontinued, and 9 that suits were pending. Johnstown, N. Y., settled 44 suits, for a total of $13,500.

In a number of places the suits have resulted in, or at least have been followed by, the establishment of sewage purification plants.

Doubtless the list of cities which have had to defend and are now defending suits on account of improper methods of sewage disposal, real or alleged, would be greatly increased if all such instances were available.

As was stated above regarding the list of sewage purification plants, notification of errors and omissions from the table of water pollution suits would be welcomed, as would also further details regarding any suits of this character.

LETTERS TO THE EDITOR.

Mortar for Use in Masonry Exposed to Heat.

Sir: In your issue of March 13 appears an inquiry from O. B. M. asking for the best mortar for firebrick or stonework exposed to great heat. In the construction of our coke ovens we invariably use common loam for the mortar for firebricks. Any good loam will do; the percentage of iron should be as low as possible, less than 2% always. The temperature in a coke oven reaches about 1,600° to 1,700° F., and the mortar stands this very well—apparently as well as fireclay. Yours truly,

Howard N. Eavenson, Assoc. M. Am. Soc. C. E.

Uniontown, Pa., March 24, 1902.

The Duluth Ferry Bridge.

Sir: Having been one of the original competitors for a bridge across the Duluth Canal, I was naturally interested in Mr. Patton's article in your issue of March 20, and would therefore ask your indulgence to make a few suggestions. After about 12 years of discussion, it does seem as though the authorities at Duluth have finally hit upon a very unsatisfactory plan. What has always seemed the proper solution of this problem to the writer was a swing bridge with unequal arms, using either a counterweight on the short arm or a pontoon on the long one; but, as this has been ruled out by the War Department, the next best thing would seem to be a [illegible] or a truss bridge, with sufficient elevation for [illegible] to pass under. There is plenty of room for approaches at both sides of the canal, and the cost would be [illegible] more than for the plan finally adopted. Besides, absolutely necessary, the approaches could be omitted [illegible] use of elevators at both sides of the canal, so [illegible] that one car would counterbalance the other, [illegible] while the other went down. The engine power would then only be what was necessary to move the traffic, [illegible] amount to no more than that required to move [illegible] shown in the present arrangement, besides having [illegible] vantage of not interfering with the canal [illegible] in any way. Yours respectfully,

Savannah, Ga., March 26, 1902. A. S. [illegible]

Requirements in Letting Government Contracts.

Sir: Noting the letters from "S. J. F." and your comments thereon in your issue of March 27, it would seem that the officials of the Navy Department could obviate trouble with irresponsible bidders were they to adopt the method of the U. S. Engineer Corps, who, in asking for bids upon important work, frequently compel filling out the bidding form with such information as the following:

(1) A list of plant and its condition.
(2) Where located (in order to examine same before awarding contract if thought advisable, which examinations we have known to take place).
(3) An examination of similar work done by the bidders, to set forth the experience gained. This is an important point, though it might tend to shut out responsible concerns about to start in business.

To be sure, the above method may be more applicable to river and harbor work, where plant of a special design is required, yet it could be adapted it would seem to the more ordinary requirements of the Navy Department.

Your correspondent seems, however, to have lost sight of certain facts which have important bearing on the subject, i. e., the system of bonds and the compulsory award of contracts to the lowest bidder who complies with the requirements of the specifications.

I have known several public officers who regretted their obligation to award contracts to irresponsible bidders, but they had no alternative as everything being in legal form, coupled with "lobby" influence, they were compelled to do so. Several years ago the War Department for a time compelled bidders to give surety companies for their security. This requirement was overruled at Washington as it was found that existing laws did not authorize it. Would not the passage of a law compelling bidders to submit with their bids bonds from a responsible surety company help out the situation? Certainly parties who are irresponsible, to my knowledge, would not be able to get bonds from a good company, whereas they have no difficulty in getting "straw bonds" to any amount from individuals.

R. L. W.

Jersey City, N. J., March 29, 1902.

Eliminating the Turnout in Computing Track Connections.

Sir: For making track connections, reverse and simple curve problems as found in the field books in general use to-day are impracticable because the standard switches or turnouts with their angles, curves and tangents, the first at the point of switch, the last always through the frogs, are never properly considered.

A problem of frequent occurrence in maintenance work is to lay out a standard turnout followed by a curve of a certain degree springing at the heel of the frog and reversing with or without an intermediate tangent so as to end in a tangent at a certain distance from and parallel to the main track.

Given the distance between the track and the proposed siding, and the degree of the curve to be used, the essentials of the location are the determination of the total central angle and the latitude of the end of the reverse curve.

In the figure, let

AG = distance c. to c. between the track and proposed siding.
P = point of switch.
PH = lead of turnout + distance point of frog to heel.
F = the frog angle.
α = the total angle.
R = radius of curve of D degree.
T = point of reverse curve.

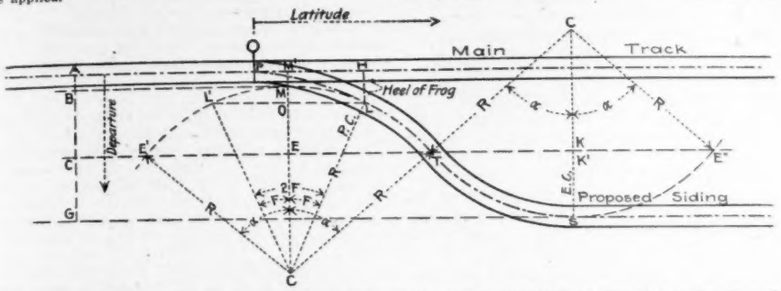
L is on the center line of the turnout opposite the heel of the frog and is the P. C. of curve of R radius. H L is its departure and is a fixed distance on the various standard turnouts, depending on the number of the frog and the distance point of frog to heel. (Calling the latter distance p h, $H\,L = \frac{gage}{2} + \frac{gage}{2} \cos F + p\,h \sin F$.)

Now extending the curve back through an angle = F to the point M, tangent from which point is parallel to the track and has a departure of H L — M O = A B.

Extending the curve again through an angle = F, it is seen on inspecting the figure that M O is the middle ordinate and L L′ the long chord of an arc of radius = R

and central angle = 2 F and are both readily obtainable from a table of middle ordinates and long chords to a 1° curve as found in Shunk's "The Field Engineer," their values being inversely proportional to D.

Now using this value A B as a correction, subtracting when M falls between the tracks and adding to the distance between tracks when it falls outside, the problem is reduced to the simple one of finding the value of the angle α as though there were no switch in the connection, and some of the problems, as found in the field books, can now be applied.



By a further use of the middle ordinate and long-chord table method, the problem may be easily and accurately solved as follows:

B G = corrected distance between tracks.

$\frac{B\,G}{2}$ = K S = mid. ord. of curve of D degree and central angle = 2 α.

K S × D = mid. ord. of curve of 1° and central angle = 2 α.

Using this as an argument 2 α is found by inspecting the table.

In case it is desired to have a tangent of certain length between the curves, by assuming a value for K'S less than $\frac{B\,G}{2}$ and finding the angle for this middle ordinate in exactly the same way as above, the length of the tangent is (B G − 2 K'S) cosec α' where α' is one-half the central angle for the mid. ord. tried. One or two trials will usually suffice for determining the tangent.

To find the latitude of S, O L = $\frac{L'\,L}{2}$, is readily determined from the long-chord table at the same time the value M O is found, remembering that its value is inversely proportional to D.

Then P M′ = P H − O L.

It is seen from the figure that E K = E′ T = T E″, the long chord for arc of R radius and angle = 2 α, divided by D. This value is computed from the table at the same time the angle 2 α is determined.

Latitude of S = P M′ + E K.

To obtain the quickest results in computing track connections as outlined above, one should provide himself with a set of diagrams of the various switches and frogs in use by the railroad, showing all dimensions, especially P H and H L, and the middle ordinate and long chord to a 1° curve for an angle = 2 F.

C. M. Kurtz,
Asst. Engineer, San Francisco & San Joaquin Valley Ry.
Stockton, Cal., March 1, 1902.

Priming Centrifugal Pumps.

Sir: In your issue of Feb. 23 the letter of Mr. B. H. Heyward in relation to "Priming of Centrifugal Mine Pumps" and your editorial notes relating thereto, as well as the solution set forth by Mr. E. F. Doty in your issue of March 13, constrain me to make some remarks upon the subject.

Some time ago, when it became apparent that some other than the ordinary method of priming centrifugal pumps must be considered, particularly when the electric drive was introduced, and in the absence of steam or other suitable agency, I devised a very simple contrivance consisting of a rotary vacuum pump (Turner type), operated by belt or friction contact from shaft of motor. It was employed in numerous plants furnished by the Prindle Pump Co., among them being one for the model basin at the navy yard, Washington, D. C., Newport News Ship Building Co., and for a three-phase centrifugal dredging plant installed by my company in Brooklyn. In every instance it has been found to operate satisfactorily, I believe, with the exception of the latter plant, which was effected eventually in the manner described by Mr. Doty, but with vacuum pump driven by dredge motor and the vacuum pipe attached to top of elbow.

The conclusion I wish to be drawn is that it is entirely unnecessary to use an independent motor to drive a vacuum pump for priming either electric, steam or belt driven machines. With an electric or belt-driven centrifugal, pumping sand, gravel or gritty liquid, the pump should be equipped with a vacuum connection at the highest point of the elbow or casing to which the water finds its way under vacuum. This applies to both single and double suction types, and when double suction is used the vacuum riser should be attached to both of said points.

To not only create a vacuum to prime, but to maintain the same while dredging in presence of gritty material destructive to the operation of any vacuum device, it is necessary to elevate the vacuum riser from the centrifugal pump high enough to prevent the liquid passing over, i. e., slightly higher than a column equal to a working vacuum, say, 30 ft. above the surface of the sump. When water jet or dredging jet heads are used at foot of suction, or when working in material yielding gas or by reason of leaks in suction pipe, in bearings of pump or casing and from other causes, it is well known by dredging men that the vacuum is frequently lost and work interrupted, resulting in many temporary disadvantages.

To dredge economically, the operation should be as continuous as possible. To do this a continuous vacuum can and should be maintained, and no second motive power is needed to perform this small but most important service. A centrifugal dredging pump is but a small part of a dredging plant, and a proper priming device is the key to its continuous working, other things being equal, as is evidenced in the letter of Mr. Heyward. But if arranged as shown by Mr. Doty, taking the air from top of pump or volute, the priming can only be accomplished when the pump is at rest; for it will be clearly seen that as soon as the centrifugal action is set up in the dredging pump, and when only partially primed, the vacuum pump will pump water instead of air, while the remaining air centers itself about the shaft or runner and inlet and restricts the flow.

Your space will not permit me to go into this interesting subject further at this time, but let me add that a centrifugal dredging pump should be started before priming, and after priming the valve immediately at the discharge (with or without a check valve) must be hand-controlled under most conditions, so as to restrict the velocity or volume of discharge to equal that imparted to the suction column. The centrifugal wheel or impeller will otherwise break the vacuum by ejecting liquid from the pump casing before the inertia of the suction column is overcome, resulting in the air escaping from the discharge pipe to the pump casing, as above explained. This danger is overcome by slowly opening the valve at the discharge end. A double disk valve, though worn by use, may be made temporarily tight to effect the priming of the pump by admitting within the valve casing a column of water through one or more openings, and may be so arranged as to keep the seats and operating parts of the valve free from sand and other obstructions.

In my experience I have found it desirable to eliminate a foot or check valve whenever possible.

Yours very truly, Roscoe S. Prindle.
120 Liberty St., New York, March 21, 1902.

FLEXIBLE METALLIC HOSE.

One of the "foreign wrinkles" which particularly impressed American engineers visiting the Paris Exposition was the extensive use of flexible metallic hose, which was seen applied to a great variety of purposes for which rubber hose is alone used in the United States. We illustrate herewith the Witzenmann metallic hose, which after successful use abroad for a considerable time is now being introduced in this country by the American Metal Hose Co., 40 Dearborn St., Chicago. As shown by the section in the accompanying cut, the hose is constructed from a metallic tape of special section which is coiled in the form of a spiral so that the edges overlap and interlock tightly without detracting from the flexibility. As the tape is coiled it forms a groove for the reception of a packing which is completely inclosed by the metal as it coils, and remains protected from internal or external wear and tear. The packing makes the tubing perfectly tight, while the flexibility is superior to that of rubber hose of equal diameter.

In Fig. 1 is shown a section of the single hose, with the metal tape or ribbon of special section coiled upon itself so that the grooves interlock. In hose of this kind for light work, a rubber packing is wound between the overlapping edges of the metal ribbon. In the style shown in Fig. 1, however, this packing is held in a V-shaped groove formed in the tape, thus making a much more secure joint. The double hose, shown in Fig. 2, is constructed of two separate coils, one within the other and firmly fastened at the ends. The coils of each tube are in opposite directions. While the single tube may become untwisted from careless handling or when subjected to great strain, this cannot occur with the double hose, which, it is said, can be made to meet any demands as to tightness and power of resistance. For special purposes it is claimed that it can be made to withstand pressures up to 3,000 lbs. per sq. in. For conveying greasy liquids, which rapidly rot rubber, this hose has given especial satisfaction, as the flexibility is increased by the lubricating nature of the liquid passing through it and its life is thereby prolonged.

In this country the Witzenmann hose is being used for steam rock drills, and also for steam jets in cleaning the soot from boiler tubes. The Metropolitan West Side Elevated Ry., of Chicago, is using the double hose for this purpose, under a pressure of 165 lbs. Rubber hose formerly used lasted only from one to four weeks, the inner tube being generally punctured by the steam, and then the entire tube blown out. The metal hose is lighter than the rubber hose, and easier for the men to handle. The double hose is also being used for the same purpose, and under a pressure of 140 lbs., in the boiler house of the Chicago Edison Co., where it is found to be very light and convenient, and with no tendency to twist. A single-ply metal hose, however, was found to kink and leak on account of being repeatedly thrust in and out of the boiler. Formerly a four-ply rubber hose was used, but owing to the high pressure and the temperature of the steam this would not last long. In Europe, as already noted, this metal hose is used extensively for a great variety of purposes, including connections from gas mains to stoves and heaters, and gas tanks, for carrying soap-water to the cutters of machine tools, and for general use in connection with steam, water and oil, piping. It is said that 5,000,000 ft. of the hose are in use in Europe.

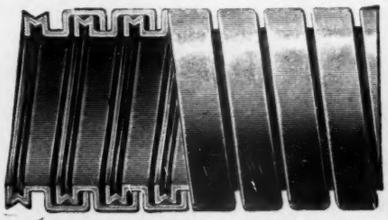


Fig. 1. Single-Ply Hose.

Fig. 2. Double-Ply Hose.

WITZENMANN METAL HOSE FOR STEAM AND OTHER CONNECTIONS.
American Metal Hose Co., Chicago.

THE INDUSTRIAL USES OF ALCOHOL IN GERMANY.

This subject is discussed by Mr. Frank H. Mason, U. S. Consul-General at Berlin, in connection with an Alcohol Exposition which was held in Berlin, on Feb. 8-16; the exhibits being confined to those directly concerned with the production and use of alcohol for domestic and industrial purposes. Germany has no natural-gas-wells or natural petroleum supply; but she produces cheap and abundant crops of potatoes from which vast quantities of raw alcohol can be simply and

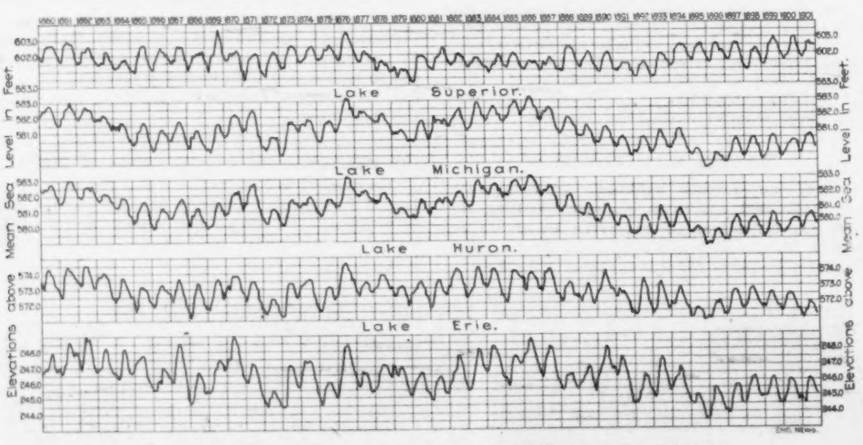
cheaply made. Crude molasses, a refuse product from beet-root sugar manufacture, can also be utilized in the same way. In 1901, no less than 30,624,000 gallons of denaturized alcohol was consumed in Germany for technical purposes.

The exhibits were divided into classes, showing apparatus for making alcohol; motors and motor-vehicles using alcohol; appliances for illuminating by spirits; apparatus for heating, cooking, etc., by alcohol flame; and those showing the uses of alcohol in chemistry and the useful arts. The Daimler Co. showed a 10-HP. military engineer's wagon, for carrying tools, etc., at a speed up to 10 miles per hour. Kühlstein & Co., of Berlin, exhibited an alcohol-motor wagon, and a coupé of the same type. But the chief interest was centered in the stationary and portable internal-combustion engines for agricultural and manufacturing purposes. These included engines, of from 1 to 20 HP., adapted to consume alcohol. Alcohol is clean and also absolutely free from the odors which render hydrocarbon engines offensive to many. At the German price of 13½ cts. per gallon, alcohol competes economically with steam engines and other forms of motor in sizes below 20 HP. For cooking and heating purposes the exhibition showed a great variety of apparatus; one of the neatest being a spirit flat-iron. The lamps ranged from those burning alcohol vapor under a mantle of the Welsbach type to an incandescent light of intense power. The Phoebus ceiling lamp is claimed to give a light of 85 c. p. at a cost of ¾-ct. per hour; and the "Bogenlicht," or arc-lamp, is said to yield 550 c. p. with an advantage of 66% in economy over electric lamps of the same power, under Berlin rates for current. The alcohol for lighting purposes costs 21.7 cts. per gallon.

The German law of 1887 is so framed as to maintain a high revenue tax on alcohol intended for use in beverages; but it exempts from taxation alcohol which is "denaturized," and intended for industrial purposes. The "denaturizing" consists in mixing with the alcohol some foreign substance which does not interfere with its use for industrial purposes, but renders it unfit for consumption as a beverage. These substances include pyridin, picolin, benzol, tolual, xylol, wood vinegar and other similar products. The wisdom of this law is shown by the fact that for every dollar sacrificed in revenue the Empire has gained tenfold in the stimulus given to agriculture and the industrial arts.

CHANGES IN THE LEVELS OF THE GREAT LAKES.

We reproduce herewith a chart recently compiled from the official records of the U. S. Lake Survey, showing the changes in level of each of the Great Lakes since 1860. The chart is made up from the record of monthly mean water levels, and was prepared under the direction of Major W. L. Fisk, Corps of Engineers, U. S. A., in charge of the office at Detroit. Besides the annual variations in level, the variations which extend over a period of years are seen to be of very considerable importance. It appears from the chart that from 1886 to 1895 there was a general fall in all the lakes except Superior. Since 1895, these levels have been either stationary or slightly increasing. No effect of the outflow from the Chicago Drainage Canal, which was opened at the beginning of 1900, can be discerned on the chart. For the two years, 1900-1901, Michigan, Huron and Ontario show a slight increase in height, and Erie a slight decrease.



CHANGES IN THE LEVELS OF THE GREAT LAKES, 1860-1901.
Compiled from Official Records of the U. S. Lake Survey, Major W. L. Fisk, Corps of Engineers, U. S. A., in charge.

NOTES FROM THE ENGINEERING SCHOOLS.

NEW YORK UNIVERSITY.—The Council of the University announces that the University Summer School for 1902 will be transferred to the University Building on Washington Square, New York city. This is done at the request of students, as being more convenient to the majority. This school opens on July 4, 1902.

UNIVERSITY OF MICHIGAN.—Owing to the great increase in the number of students in engineering, the Regents have decided to erect a new building to be devoted exclusively to the technical branches of engineering. This building will contain large and well-equipped laboratories for work of students in the civil, mechanical, electrical and marine engineering courses. The latter department will be exceptionally complete, and will be one of the best equipped schools of its kind in the country. It will include an experimental model testing tank, 300 ft. long, 22 ft. wide and 10 ft. deep, permitting the testing of models 12 to 14 ft. in length. There will also be a workshop with machinery for making models of ships and propellers. This department will be under the direction of Prof. Herbert C. Sadler.

TYPHOID FEVER DUE TO ALLEGED IMPROPER MECHANICAL FILTRATION AT CONNEAUT, O.

An outbreak of typhoid fever at Conneaut, O., is attributed by Mr. Benj. H. Flynn, Engineer of the State Board of Health of Ohio, to the improper operation of the mechanical filter plant which forms a portion of the plant of the Conneaut Water-Works & Supply Co. From Jan. 1 to March 18, 1902, there were 65 cases of typhoid fever and three deaths therefrom in Conneaut. Investigations showed no apparent connection with the milk supply. Eliminating one patient who came from Cleveland, 58 of the 64 used the public water supply to a greater or less extent. The cases were well distributed over the city. Mr. Flynn's description of the water supply in its relation to the outbreak, as given in an official report dated March 25, is as follows:

Conneaut is supplied with water secured from Lake Erie at a point 570 ft. from the shore line and in 14 ft. of water. The lake is here polluted with the sewage-laden waters of Conneaut River, which enter the lake some 1,500 ft. east of the intake, and by the washings from the filthy yards, streets and outhouses of the northern part of Conneaut, which surface drainage enters the lake just west of the pumping station. These conditions demanded that the lake water be purified before using the same. For this purpose a system of mechanical filtration was installed in September, 1900. Upon the successful operation of these filters depends the purity of the public water supply, and in this system of mechanical filtration successful operation depends largely upon the use of a proper amount of coagulant, in this case sulphate of alumina.

From July 29, 1901, until March 18, 1902, for which term records were available, there was used on an average only ¼ grain of alum per gallon of water filtered. From the statement of the engineer, the amount of alum so varied with the turbidity of the water, a clear effluent being the only gage of successful filtration.

During the winter of 1901-2 the ice extended from the lake shore out over the intake and harbor for a number of miles. Beneath this ice layer the lake waters were held quietly imprisoned, resulting in a very clear water being brought to the filters. As a clear water was the only gage, this condition resulted in the use of the minimum amount of alum, probably less than ¼ grain per gallon. As under the conditions named the sewage from the river enters the lake without any purification by wave action being possible, and when it can spread out over the intake without being influenced by the wind, it is believed that the water sent to the filters is more seriously polluted than at any other time and demands the highest efficiency in the filters.

This is borne out by the fact that during the latter part of February, owing to the increase in the number of typhoid fever cases, the amount of alum was increased to about 0.7 grains per gallon, resulting in better purification, which checked the number of cases of fever, when the period of incubation is allowed for.

Owing to the peculiar conditions resulting from the formation of ice over the intake and harbor, it is believed that the water at the intake demands the highest efficiency in the filters, notwithstanding the apparent purity of the same due to its clearness.

It would no doubt be wise to increase the amount of alum at all times owing to the opportunity for serious pollution and on account of the facts as cited above to increase the amount much above the normal for a period beginning with the formation of the ice in the winter and extending to such a time as the ice is broken up and the lake cleared up in the spring.

Owing to the changes in the lake water due to seasons, direction of wind, etc., it would be advisable to conduct a test of the filters under all possible conditions and determine the proper amount of coagulant to use for each case.

Mr. Flynn's report is accompanied by analyses of the Conneaut water before and after filtration, made by Mr. E. G. Horton, Bacteriologist and Chemist of the Board. The analyses bear out the general conclusions submitted by Mr. Flynn. The reports of both Mr. Flynn or Mr. Horton indicate that the filters might have been so operated as to have given a perfectly safe effluent, but that no means of testing their efficiency was employed.

BOOK REVIEWS.

HANDY TABLES FOR ELECTRICAL AND STEAM ENGINEERS.—New York: The American Electrician Co. Paper; 6 × 9 ins.; pp. 13. Price, 50 cts.

This is a collection of 18 tables, of which 10 relate to electrical computation and the remainder to mechanical engineering matters, such as belt and pulley speeds, pump capacity, boiler output, etc. We see no excuse for setting so high a price on a pamphlet of a half dozen leaves without even a paper cover.

A HAND-BOOK FOR APPRENTICED MACHINISTS.—Edited by Oscar J. Beale, Providence. Brown & Sharpe Mfg. Co. Cloth; 4½ × 6 ins.; pp. 141. Price, 50 cts.

This is a little booklet prepared to instruct machine shop apprentices. It was originally prepared for the use of apprentices in the Brown & Sharpe shops, and was found so useful that it was decided to give it a wider circulation. The book covers excellently the few subjects of which it treats.

THE KNIGHT OF THE GRIP.—A series of articles reprinted from "The Iron Age." Cloth; 5 × 7½ ins.; pp. 179. New York: David Williams Co. Price, 60 cts.

In a brief preface the unknown author says of the book: "There is not a word of advice in it. It may serve to while away an idle hour." Notwithstanding this, there is much practical advice in it, though indirect, and every traveling man, even if his line be not hardware, can get something out of it. It is a rambling dissertation on drummers and buyers, and the author manages to bring a good deal of human nature into his writing.

THE STEAM ENGINE PROBLEM.—By S. H. Barraclough, Assoc. M. Inst. C. E.; P. N. Russell School of Engineering, University of Sidney, Sidney, Australia. Cloth; 6 × 9½ ins.; pp. 47.

The author of this work will be remembered by some American engineers as a post-graduate student at Cornell a few years ago, where he conducted some experiments in thermodynamics. The present work is a reprint of a series of papers published in the "Australian Technical Journal" and is, the author confesses, rather fragmentary in character. The articles are written in a readable manner and

are designed to make clear the principal facts regarding the steam engine to students having only an elementary knowledge of the subject.

VELOCITY DIAGRAMS.—Their Construction and Their Uses. By Chas. W. MacCord, Professor of Mechanical Drawing in the Stevens Institute of Technology. Cloth; 6 x 9 ins.; pp. 116; 83 illustrations. New York: John Wiley & Sons. Price, $1.50.

The presentation of the subject in this volume is remarkably simple and clear; its accuracy of language should do a great deal toward giving the student that sureness of knowledge which he ought to possess in regard to matters of theory, whether expressed in calculations or in diagrams. The book is intended not only for the classroom, but also for self-study, and will doubtless find much favor in this field. The book considers first the preliminary theory, and then applies this to different forms of linked and rolling contact mechanisms. Motions used for operating the ram in shapers are given particular attention.

THEORETICAL ELEMENTS OF ELECTRICAL ENGINEERING.—By Chas. Proteus Steinmetz, President American Institute of Electrical Engineers. New York: The Electrical World and Engineer. Cloth; 6½ x 9½ ins.; pp. 327; with 143 illustrations. $2.50.

The first third of this book is devoted to a discussion of general electrical theory. While the author begins with elementary principles, his treatment is by no means elementary and the student will need to be well grounded by the aid of a simpler treatise before undertaking this. The author proceeds at once with practical examples of computations relating to electrical apparatus and this part of the book would appear to be particularly useful to the student endeavoring to become familiar with practical work in the design of electrical machinery.

Part II. is devoted to a description and elucidation of the theory of special types of apparatus. These the author divides into four classes as follows: Synchronous machines, commutating machines, synchronous converters and induction machines. The electrical characteristics of a large number of machines is described under each of these heads.

The book contains very little of explanation. Its writer evidently had little thought of helping his reader over the hard places. Doubtless, like many another expert, it never occurred to him that there were any hard places in the science with which he had become familiar. For the advanced student working with the aid of competent instructors, we judge it to be a most valuable and indispensable text-book.

A QUARTER CENTURY OF CREMATION IN NORTH AMERICA.—By John Storer Cobb, Hon. Pres. New England Cremation Society. Boston: Knight & Millet. Cloth; 5 x 7 ins.; pp. 189; tables and one illustration. $1.00.

The sum total of 25 years of cremation of the human dead on this continent has been 13,281 bodies consumed up to the end of 1900, with 26 crematoriums in operation at the close of the period. While this seems small, indeed, when compared with the total number of deaths, which now exceed a million a year in the United States alone, yet the progress has been rapid of late, compared with the earlier days of the movement.

The author first gives a general review of cremation in North America, and then describes each one of the crematoriums now in operation, including its history as well. There is also a less extended outline of cremation in Europe. Then follow a number of tables showing the number of bodies burned each year, in both the American States and the various countries of Europe. The book also contains a selected bibliography of cremation in the nineteenth century, and there is an appendix consisting of an address delivered by the author before the New England Cremation Society in 1891.

The author devotes far more space to the historical phases of the subject, and to the architectural features of the chapels and other buildings connected with the crematoriums than to the design and operation of the incinerating furnaces. But the book does give a fair general idea of most of the furnaces, with details of a few of them, and the names of the designers or builders of nearly all the American appliances.

Whatever views prejudice, sentiment or religion may prompt regarding the cremation of the dead, all must agree that the process is incomparably more sanitary than burial. Engineers, in particular, will appreciate this fact.

COMMITTEE REPORTS AT THE CONVENTION OF THE RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

We conclude our report of the proceedings of the recent annual meeting of the Maintenance-of-Way Association with abstracts of the committee reports on "Yards and Terminals," "Iron and Steel Structures" and "Records, Reports and Accounts:"

Yards and Terminals.

TYPES OF CLUSTER (OR GENERAL YARD).

Two plans have been prepared, designed in accordance with the recommendations made in the first report. The clusters (or general yards) are especially designed to eliminate interference in the operation of yards from all causes. In preparing the plans it was found that less interference was caused to switching and road movement and the main tracks less obstructed where the engine house is located in the center of the yard and the main tracks spread about or run around the yard; both of the types of cluster (general yard) are designed with this end in view. In one of them the yard embraces receiving, separating, classification, storage and departure tracks; in other words, it has the complete series. The yard could be operated either as a poling or summit yard. In the second plan the more common practice of having merely receiving, separating or classification and storage tracks is pursued. Departure tracks are not shown; they cannot usually be provided on account of the great length of the yard which they involve.

In either of the plans the "summit" feature can be developed nicely by locating mounds between the receiving, separating and classification yards. Were it necessary to locate the cluster on a grade falling in one direction, it would usually be policy to change the arrangement of the yard; in other words, to locate the receiving yards for cars going in both directions at the upper end of the cluster (or general yard), so that the switching would all be done in the direction of the grade. This would occasion some change in the detail.

FREIGHT CAR REPAIR YARD.

A repair yard should be located at or near the terminal or point where cars are naturally made empty. The location selected should be such that labor and material can easily be obtained. The yard should be so located that cars to and form the cluster (or general yard) and local yards and unloading points can easily be switched in and out of it without stopping work on more than the one repair track used or interfering with general yard switching. It should also be near enough to these points that switching will not be expensive.

Repair yards should be composed, as a general rule, of short tracks of a capacity of 10 or 15 cars each, so arranged that they will be in pairs. The tracks of each pair should be spaced 16 ft., c. to c., and the pairs should be spaced 40 ft., c. to c. The material supply yard for this type of repair yard should be located at the end of the repair tracks, so that material can easily be trucked into the openings between the tracks and along these openings to any point in the repair yard. Part of the yard should be provided with air and water pipes for testing refrigerator and other cars. Air and water connections should be spaced 50 ft. apart. The yard should also be drained.

In calculating the size or capacity of repair tracks, cars should be considered 50 ft. long, so that there will be an open space of 10 or 12 ft. at the end of each car for handling material, trucks, etc. At points where nearly all the work done is light repairs it will sometimes be of advantage, on account of lack of room, to space part of the tracks 16 ft., c. to c. On account of the small amount of material required in making light repairs, it can easily be moved to any car located on tracks thus spaced.

Long repair tracks are objectionable, because of the difficulty in switching out the repaired cars and the delay in waiting for the entire cut of cars to be repaired. The yard should be lighted. If it is not necessary to work at night, the yard should be switched at that time, so as not to interfere with the work. Less switching and delay will be had where light repair cars are kept on tracks separate from the heavy repair cars. Light repairs are sometimes made on the yard tracks, and it will quicken the movement of cars to so arrange that there will be a track for holding cripple cars between the receiving and separating yards of a cluster (general yard). Tinker or very light repair cars should in nearly all cases be repaired on the track on which the cars stand; they should not be moved to the regular repair yards or tracks except in exceptional cases.

PASSENGER COACH AND CAR CLEANING YARD.

Geographically the location should be at the terminal or end of train run, and locally it should be such a location as is easy of approach to and from the terminal station or end of train run. A "Y" track for turning trains is almost always necessary and the movement to or from it and the yard and station should be free. In large cities the value of land will often prevent the building of a "Y," and in such cases a turntable capable of handling the largest car seems to be a necessary adjunct.

In order to avoid empty mileage and delay, this yard should be near the terminal station. It is sometimes of advantage to have it connected at both ends, but tracks connected only at one end are usually used. The yard should be composed of tracks spaced about 20 ft. c. to c. Some space can be gained by putting them in pairs, with the tracks of each pair 16 ft. c. to c. and the pairs 36 ft. c. to c. Where the value of land limits the size of the yard, and thus controls the spacing of tracks, it is felt that tracks can be reduced to 14 ft. c. to c. This is the minimum, and should not be used where the greater distance can be had; it will allow the men to pass.

In some cases it will be quite an advantage to have the yard (or at least a few of its tracks) connected at both ends. If the yard is not connected at each end, at the blind end of tracks, and running at right angles thereto, a car cleaners' supply building should be located, with a space between the building and the end of tracks sufficient for the trucking of material to any of the openings between them. The building should be of sufficient size for all supplies, for electrical arrangements, boilers, dynamos, compressed air plant, steam heat, gas, repair material, dining and sleeping car supplies, oil, waste, etc. If the yard is connected at both ends, this building will have to be at one side, but the yard will usually work to better advantage with it at the end on account of the ease with which material can be trucked to any point in the yard.

The yard itself should be provided with water, steam and air pipes running down between alternate tracks, and, where necessary, with proper arrangements for furnishing gas and electricity. The connections should be 50 ft. apart. The yard should be sewered between each pair of tracks. Some kind of permanent staging should be provided between each set of tracks, from which the cleaning can be done, and which will give the men employed there an opportunity to readily reach the roof of the car as well as the lower parts; a system of poles and brackets, or a trolley arrangement from overhead supports, is suggested. The yard should be well paved or planked, to allow of drainage and of being kept clean and free from dust. A permanent paving is desirable; planking is not, as the use of soap, acids, water, etc., in cleaning will soon cause it to rot. The track should be of sufficient length to handle trains without cutting them. In designing the yard, the length of trains to be handled should be considered, so that the tracks may be made of proper length; where more short tracks are required the ladder can be made to run each way. The yard should be lighted, so that work can be done at night where necessary.

IN-BOUND FREIGHT HOUSE.

If possible, it is well to locate an in-bound freight house so that the empty cars made at the out-bound houses or transfer houses can be moved directly to the in-bound houses without interference or delay. In some cases, by having adjoining houses, they can be used without being switched. The location should be as convenient as possible to the business district. Approach from it should be by streets, the grade of which is not great enough to burden the teaming community, say, not over 4%. This figure, however, will vary in each locality. In Chicago, where there are practically no grades, a 4% grade is burdensome. This would not be the case in Pittsburg, where many of the street grades are as high as 7%.

On account of the speed with which the cars in in-bound houses can be unloaded, it is not often of advantage to have over two tracks at the house; thus it is only necessary to unload through one car. Unloading through cars is always objectionable, as it makes the spotting of cars at the freight house necessary, unless 8 or 10 ft. platforms are provided between tracks, and this spotting consumes time in getting the cars in shape for unloading at the house, thus reducing the capacity and increasing the cost. The platforms should be provided wherever space will permit of it. The arrangement of tracks should be such that the cars at the house can be pulled out and new loads set in a minimum amount of time; this is usually provided for by a small auxiliary yard, about as shown on the sketch. It should hold at least as many cars as the freight house tracks accommodate. A cut of empties is pulled back to one of the tracks in the yard and a new cut of loads shoved in. The second cut of empties is pulled out from the house and the second cut of loads shoved in. The empties are then all taken to the cluster (general yard), or to the out-bound house, and a new supply of loads set in the smaller yard ready to be switched as soon as those at the house are empty. The track approach to the freight house from the main tracks should be such as not to cause delay. Where the small yard cannot be provided, a lead track should at least be built, to avoid switching on the main tracks.

The proper width of in-bound freight houses is 50 ft. The proper length depends upon the amount of business to be done and the allotment of ground for the building. This also sometimes affects the width of the house. The proper minimum width of the roadway where the in-bound house is on one side of it and a wall on the other side is 30 ft. The proper minimum width of roadway where the in-bound house is on one side of it and a team track or in or out-bound freight house is on the other side is 40 ft. The proper additional width, or the distance that the in-bound house should be set back from the street where it is parallel to the street, for a space in which teams are to stand when wagon is backed against the freight house, is 20 ft. Between the side of the house and the near track there should be a platform 8 or 10 ft. wide, to obviate the necessity of spotting cars at doors.

In-bound freight houses will frequently have to store large quantities of freight, and in order to do this and not interfere with the prompt movement of business on the first, or ground floor, it is frequently necessary to build such houses several stories high, the upper floors to

be used for storage. These floors should be spaced 10 ft. apart in the clear, and material should be lifted to them in elevators and endless chain conveyors. The lower floor is sometimes arranged to slope slightly in the direction of the load, though not much is gained by this.

The business to be accommodated must govern the style of structure, considering volume, kind and character of traffic, the time it must remain on the floor, etc. In large cities in-bound houses usually are separated from out-bound and transfer houses, due to lack of room to combine them. It is best, however, where possible to do so, to at least have the in and out-bound houses close together, so as to decrease the amount of light wagon mileage to a minimum; where they are together a wagon will deliver and remove a load with no light mileage. In small towns and cities the houses should usually be combined. It is desirable to provide in-bound houses with an overhead crane reaching over two tracks, a platform and a roadway, to admit of the transfer of heavy loads from car to car, platform or wagon. A cold room should usually be provided for storing butter, eggs and other refrigerator car freight awaiting delivery. In winter this room can be used for fruit, to prevent freezing. Checkers' offices should be located at proper intervals; they should be properly heated in winter. Electric lights on extension cords for use in cars and houses should be provided; they will soon repay their cost in quickened service. The cords should be of such length as to allow the lights to be moved about, hung on hooks, etc.

Protection against fire should be provided by placing hydrants at intervals throughout the house, about 100 ft. apart, each hydrant to be connected with proper length of canvas or other hose arranged on reel or folded in box, or stretched out at length on a shelf so that it can be put into instant service, and arrangements should be made with the city authorities for fire-alarm box and out-side hydrants where possible. In a recent fire on the Lehigh Valley R. R. the blaze spread so rapidly that the inside protection was not available. Water barrels, buckets and extinguishers should be provided at proper intervals.

It is most important to provide a good, smooth floor; it accelerates the work of trucking and reduces the cost thereof, likewise decreases the amount of loss from rough handling. Hard maple makes a very good, cheap floor, and will wear for years where not exposed to moisture.

OUT-BOUND FREIGHT HOUSE.

If possible, it is well to locate an out-bound freight house so that the empties made at the in-bound house can be moved to it without interference or delay. In some cases by adjoining houses they can be used without being switched. This plan cannot often be used, however, as unless cars for certain designated points have fixed locations, truckers are liable to make mistakes and put freight in the wrong cars. The location should be as convenient as possible to the business district (with grades as already noted).

On account of the delay in getting a full load into cars at out-bound houses, they must remain at the house a considerable time, usually all day. In large cities the tonnage shipped to many points makes it necessary to have a separate car for each station to which a necessary amount of freight is shipped. There must also be cars for the local or peddler business at small stations along various routes, each such route requiring a car. In this way the total number of cars which must be set at an out-bound house is sometimes very large, and in order to get the proper number it is frequently necessary to load through four, five, six and sometimes seven cars. It is most important, therefore, in designing such a house to ascertain the proper number of cars which should be placed for loading at the house, and a liberal surplus for the demands of the future should be arranged for. The ordinary out-bound house is arranged to load through four or five cars. If necessary to load through more than four cars, it is advisable to see if the house cannot be enlarged in other ways.

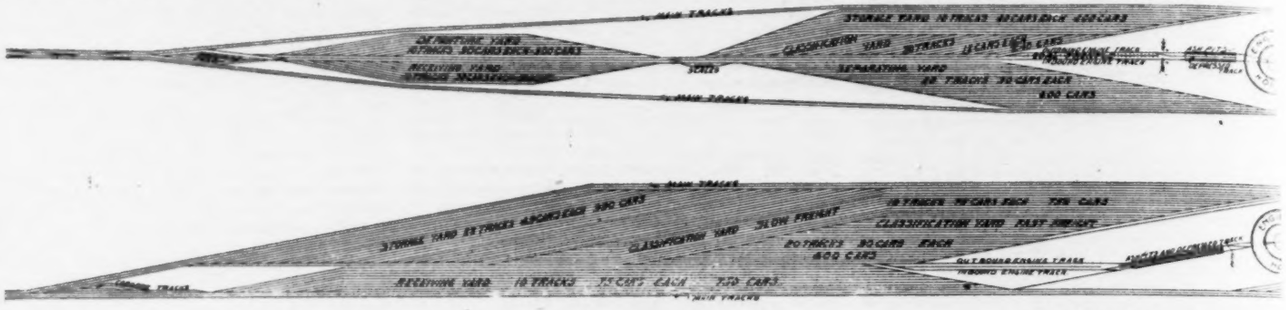
There should be connected with these tracks a small yard for the quick switching of them, so that it will not have to be done on the main track. If possible, the capacity of this yard should be at least as large as the car capacity at the house. This small yard is not as necessary here as it is at the in-bound house. The movement from out-bound houses is usually made only once a day, except in cases of special shipments, and these latter are loaded into cars at the end of the track nearest the main track, so that they can be switched or moved without interfering with other cars at the house. Between the side of the house and the near track there should be a platform 8 or 10 ft. wide to prevent spotting cars at doors; also, where room is available, it is of great advantage to construct platforms about 8 or 10 ft. wide between the tracks in order to avoid the necessity of spotting cars.

Another type, although not so common, is to have the house abut upon a street and the tracks run up to it at right angles. Between each pair of tracks there should be a covered platform about 12 ft. wide. This house has the advantage of being able to get a large number of cars at the house without the necessity of loading through cars. The average length of the truck haul is usually decreased. Such an arrangement is frequently made where it is desirable to consolidate an in and out-bound and a transfer house at one point. On one side is built the in-bound house, on the other the out-bound house, and between them the office. Cars to be transferred are set on the various intermediate tracks. The advantages of such a house are that the empties made at the in-bound and transfer houses are quickly turned over to the out-bound house, or can be used for out-bound shipments, if necessary, without switching. It gets a large number of cars at the house and enables the local agency to make shipments, on account of the cars being transferred, to many points quickly. It has the advantage of consolidating three features—an in-bound, an out-bound and a transfer house—under one set of officers and one agent. This tends greatly to reduce the cost and also to quicken the service. The tracks at all these houses should be arranged so as to require the least amount of switching and so that it can be done in the least time. The track movements from the large cluster (or general yard) to the freight house should be such as not to require time or to be blocked; it should be a free movement. Connected with this house should be a small yard, about as shown on sketch, to enable the ready switching of the cars.

The proper width of out-bound houses is 25 ft. The proper length depends upon the amount of business to be done and the allotment of ground upon which the building is built. This also sometimes affects the width of the house.

The business to be accommodated must govern the style of structure, taking into consideration volume and character of traffic and the time it will have to remain on the floor, etc. In large cities out-bound houses are usually separated from in-bound and transfer houses, due usually to lack of room to combine them. It is best, however, where possible to do so, at least to have the in and out-bound houses close together, so as to decrease the amount of light wagon mileage to a minimum. Where they are together a wagon can deliver and remove a load without any light mileage. In small towns and cities the houses should usually be combined.

It is desirable to provide out-bound houses with ... overhead crane reaching over two tracks, a platform ... a roadway, which will admit of the transfer of ... loads from car to car, platform or wagon. A cold ... should usually be provided for storing butter, eggs ... other refrigerator car freight awaiting loading. In ... ter this room can be used for fruit or vegetables, to ... vent freezing. Checkers' offices and scales should be ... cated at proper intervals; scales should usually be ... vided at each door. These offices should be ...


MAIN TRACKS
STORAGE YARD 10 TRACKS 40 CARS EACH 400 CARS
CLASSIFICATION YARD
SCALES
SEPARATING YARD
40 TRACKS 10 CARS EACH
400 CARS
MAIN TRACKS
STORAGE YARD 10 TRACKS 40 CARS EACH 400 CARS
CLASSIFICATION YARD SLOW FREIGHT
10 TRACKS 10 CARS EACH 100 CARS
CLASSIFICATION YARD FAST FREIGHT
10 TRACKS 10 CARS EACH
100 CARS
OUTBOUND FREIGHT TRACKS
INBOUND FREIGHT TRACKS
RECEIVING YARD 10 TRACKS 75 CARS EACH 750 CARS
MAIN TRACKS

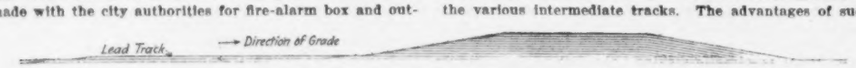
TWO TYPES OF "CLUSTER"

TRANSFER HOUSE.

Geographically the location should be at some junction point or points where there is a coming together or bunching up of the traffic and where there is a yard and a natural lay-over point at which the traffic is switched and trains are broken up, or at a point where one railroad terminates and another begins and it is desired to avoid having the cars of one road run on the other road. Locally, where possible to do so, it should be located with the in and out-bound freight houses, so that one agent and one set of foremen may have charge of all.

The purpose of a transfer house is the consolidation of less-than-carload lots into carload lots and the breaking up of cars containing shipments to many points and consolidating them into cars containing shipments for only one point or route, or the transfer of freight from car to car to avoid the use of foreign cars. In order to do this it is necessary to be able to set a large number of cars at the house. A transfer house makes cars, or, in other words, by consolidation releases loaded equipment. It is therefore of some advantage to have it located at such a point where the equipment thus released can be used.

It is usually made up of a series of tracks in pairs, with covered platforms about 12 ft. wide separating each pair. It should be so located that the supplying of cars for the transfer house to and from the yards can be done without delay. In second-class cities or at junction points the transfer house must in most cases be considered in connection with the regular station work, and should be designed with this end in view. The same care to provide proper fire protection, good floors, cranes for heavy loads, proper lighting, etc., should be taken as in the case of in-bound houses.



TYPE OF INDUSTRIAL DISTRICT YARD.

Type of Car-Repair Yard.

(General dimensions 1,100 ft. long, 320 ft. wide. Dotted lines show tracks for trucking material. Air and water pipes should be provided between all tracks spaced 24 ft. centers with plugs every 50 ft. for testing refrigerator and other cars. Yard to be so located that it can be switched quickly and often when necessary. Yard can be placed in any angles of ladder of yard. Yard will frequently have to be built with one ladder, but wedge-shaped yard is of advantage on account of uniformity in length of tracks. Spacing of 16 ft. is for yard for light repairs.)

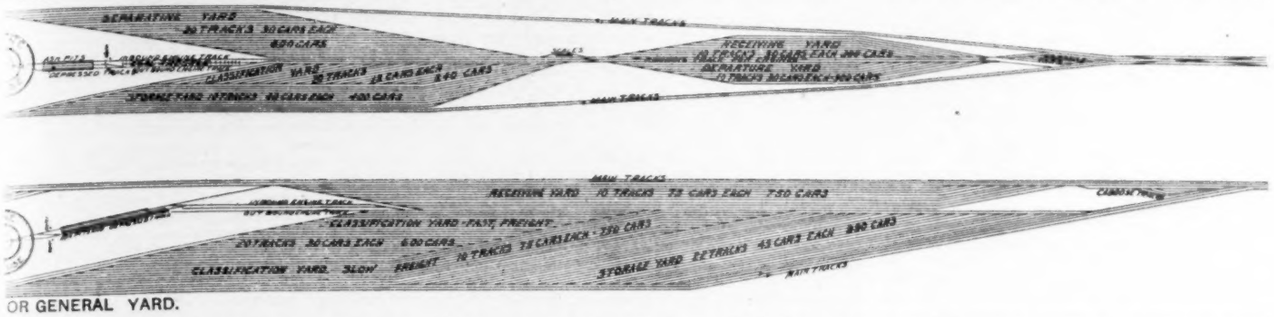
INDUSTRIAL DISTRICT YARD.

Large cities are usually divided into what are called industrial or switching districts. In each of these districts one or more engines are required to switch the team track, freight house, business sidings, etc. If the terminal cluster (general yard) is some distance from these districts, it is customary to run cars into the district from the cluster (general yard) to a small district yard by what is called a transfer engine. These engines leave the cars in the district yard, and they in turn are then delivered by the district engine to the point where needed. The yard is usually only a number of parallel tracks, on which cars are set. These parallel tracks should be so arranged with a switching lead that they can be switched without interference with the main track, about as shown on the attached plan.

TYPE OF DIVISION TERMINAL YARD.

DIVISION TERMINAL YARD.

At many points this type of yard is only needed for trains to pull into, change engines and cabooses, cut off or add a few cars to correct the tonnage for the next division, and pull out. In connection with this yard there should be a small lancing yard in which to put cars for the local trains in station order. (At points where the amount of additional business is great and trains must be broken up into many new parts, the yard takes on the

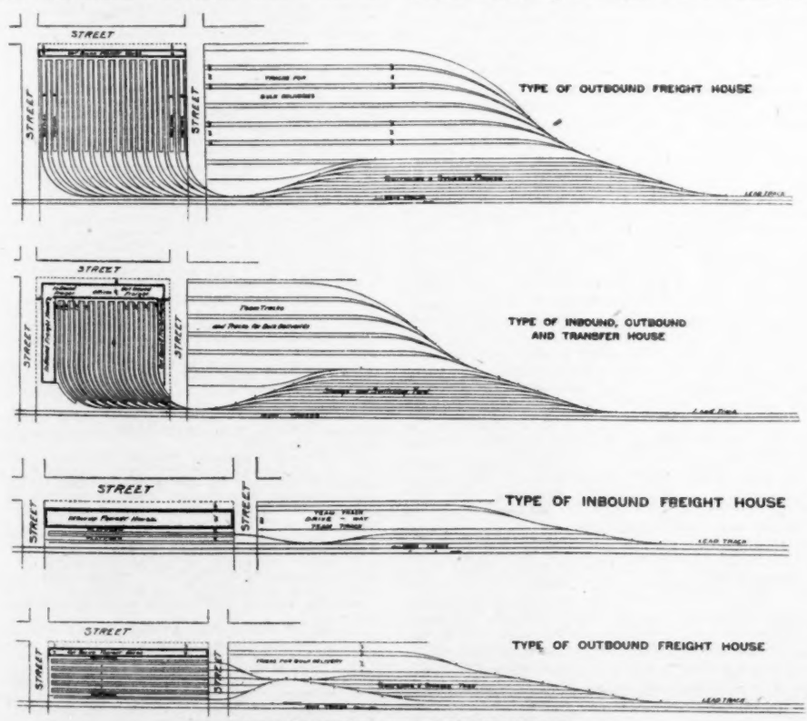

SEPARATING YARD
20 TRACKS 30 CARS EACH
600 CARS
CLASSIFICATION YARD
20 TRACKS 43 CARS EACH 860 CARS
STORAGE YARD 10 TRACKS 40 CARS EACH 400 CARS
MAIN TRACKS
RECEIVING YARD
10 TRACKS 30 CARS EACH 300 CARS
DEPARTURE YARD
10 TRACKS 30 CARS EACH 300 CARS

MAIN TRACKS
RECEIVING YARD 10 TRACKS 75 CARS EACH 750 CARS
CLASSIFICATION YARD - FAST FREIGHT
20 TRACKS 30 CARS EACH 600 CARS
CLASSIFICATION YARD SLOW FREIGHT 10 TRACKS 75 CARS EACH 750 CARS
STORAGE YARD 20 TRACKS 43 CARS EACH 860 CARS
MAIN TRACKS

OR GENERAL YARD.

features of a terminal cluster and should usually be so designed.)

In this type of yard it is most important to get the movement of engines from house and coal dock to and from yard so planned that there will be no interference or delay. The yard is usually at a division end, and is primarily a holding place while engines, crews and cabooses are changed. It is at the intermediate end of train runs and any land upon which the yards can be built will answer. It should, however, be so located that the men can get to and from it without much inconvenience, and that cars for the city or town in which the yard is located can be switched to and from the city delivery tracks or freight houses without delay. It should not be located on a limiting grade unless it runs with the traffic. When the necessity for breaking up trains exists, the yard will then assume the features of a cluster (or general yard). The size of the yard depends upon the volume of business and is best measured by the number of trains arriving per hour. The location of the engine house is most important, but must be governed almost entirely by local conditions. It should be studied with much care, so as to locate it where the movement of engines to or from the yards will cause a minimum amount of interference.


STREET
TYPE OF OUTBOUND FREIGHT HOUSE
TYPE OF INBOUND, OUTBOUND AND TRANSFER HOUSE
TYPE OF INBOUND FREIGHT HOUSE
TYPE OF OUTBOUND FREIGHT HOUSE

VARIOUS TYPES OF FREIGHT HOUSES.

C. S. Sims, Pa. Lines; W. G. Besler, P. & R. Ry.; E. E. Russell Tratman, Res. Ed. Engineering News; R. B. Tweedy, Wis. Cen. Ry.; S. P. Hutchinson, El P. & S. W. Ry.; J. B. Cox, C. J. Ry.; J. A. Atwood, P. & L. E. R. R.; G. F. Morse, L. V. R. R.; A. W. Swanitz, C. T. & C. Co.; M. S. Blaiklock, G. T. Ry.; W. K. McFarlin, D. L. & W. Ry.; I. G. Rawn, B. & O. S. W. Ry.; J. G. Rodgers, N. Y., P. & N. R. R.; F. S. Stevens, P. & R. R. R.; W. S. Kinnear, Mich. Cen. R. R.

Iron and Steel Structures.

The features of the subject selected for study and the sub-committees assigned to gather information were as follows: (1) The general practice in placing railway bridge work under contract: Mr. J. P. Snow, Mr. J. R. Worcester and Mr. William Michel; (2) specifications for roller steel: Mr. T. L. Condron, Prof. C. L. Crandall and Mr. J. E. Greiner; (3) live loads, impact and unit strains: Mr. B. Douglas, Mr. O. Bates and Mr. R. Modjeski. On subject No. 1 we beg to submit a unanimous report, as follows:

THE GENERAL PRACTICE IN PLACING RAILWAY BRIDGE WORK UNDER CONTRACT.

This subject has been studied by the committee for the reason that it is one of the essential preliminaries in the work of building a bridge, and that it is sometimes handled in a manner unsatisfactory to the builder and perhaps to the engineer responsible for the execution of the work. It is seldom that an exact duplicate of an existing bridge is what is needed to properly fit a given location and set of conditions. It remains, then, that a bridge must generally be fully designed by someone before construction is commenced and a builder chosen by some satisfactory process of selection to execute the work. These considerations indicate the two principal features to be considered: (1) The degree of completeness of plans and specifications that the railroad should furnish for the purpose of informing the bidders what is wanted; (2) the best manner for the railroad to select the proper builder to construct its work. Secondary questions to be considered are: (A) Shall bids be a lump sum for each job or by the pound? (B) Shall bids be obtained for each structure or group wanted at one time, or shall contracts be made for whatever may be wanted during the season? (C) Shall the work be erected by the contractor or by the railroad?

These five points are more or less interdependent and in turn are controlled by other elements of the problem. As railroad administration stands at present some roads have many bridges and some have few. No two are organized on exactly the same lines, and very few are subject to exactly similar conditions. The personality of the officers counts for much in the transaction of a road's business and financial considerations oftentimes outweigh all other factors. Hence it is evident that no hard and fast rule can be laid down for each of our items that will apply to all roads, but that we should aim rather to present satisfactory methods that are broad enough to cover all ordinary conditions and point out the objectionable features in the methods sometimes employed.

1. The Degree of Completeness of Plans and Specifications to be Furnished by the Railway.—Under this head there are three distinctive courses open: A, Plans of more or less detail, but sufficiently full and precise to allow the bidder to figure the weight correctly and if awarded the contract to at once list the mill orders for material. B, General outline drawings showing composition of members, but no details of joints and connections. C, A full specification with survey plan only, leaving the bidder to submit a design with his bid.

Of 72 railroads replying definitely to this phase of the inquiry, 24 roads, covering 55,809 miles, make use of couse A; 13 roads, covering 28,753 miles, use course B, and 35, covering 32,683 miles, course C. A large majority of the engineers and bridge companies responding favored the making of detail plans. The engineer of a prominent bridge building company, in his correspondence on this subject, says:

> Among the various methods now in vogue, there are two which are satisfactory. One is to furnish complete detail drawings and specifications; the other is to furnish specifications, survey plans and other information, leaving it to the bidder to make his own design. Furnishing a diagram showing composition of members only is not so satisfactory to the bidder, as the strain or section sheet is not a complete design. In order to obtain a close bid, it is essential to furnish such information as will enable the bidder to figure the cost of shop work with reasonable accuracy, which he can do only if either a complete design is furnished to him, or if he is at liberty to follow his own practice as regards details of construction, in which case he should make his own section sheet. To submit a strain or section sheet only without details to the bidder is not very satisfactory, as it will sometimes require more time and study to work up a good design from the same and at the same time conform to the sections and sizes given therein, than if the bidder would also make the strain sheet to conform to his own practice in the construction of details and connections.

It would seem to be a plain business axiom that the buyer of a bridge should know definitely what he wants before asking for bids, and, in order to enable bidders to make close prices, that he should furnish such drawings and descriptions as will leave no uncertainty as to what he requires either in the structure, the materials or the method of executing the work.

Under course A the degree of completeness of the plans must depend largely upon the preferences of the engineer and the time and office facilities available. Complete shop plans are preferred by some; what may be called engineering plans, drawn to a scale sufficiently large, say 1 in. per foot, to clearly show the arrangement of all connections, packing of pins, number of rivets, thickness and shape of all fillers, division of shop and field rivets, make-up and size of all shoes and bearings, and, in fact, how all parts of the bridge come together and how they are fastened together, but not complete enough for ordinary shop drawings, are preferred by others; while still others make small scale drawings only, showing no rivets, but covering the plan with notes and directions sufficient to guide the bidder to a fairly complete understanding of all details.

If the plans are complete enough for listing the mill orders, which must be considered the minimum requirement covered by this course, they will show the bidder clearly what the character of the shop work will be and enable him to compute the weight with precision. With this minimum in view any degree of elaboration may be indulged in that the engineer deems advisable.

If a large quantity of work is wanted when it seems probable that prices will advance, it may be advisable to get it under contract at once before drawings can be made. In this case a description of the work wanted, with approximate weights, accompanied if possible by detail plans of similar bridges, may be sent to bidders, and

prices obtained per pound; detail plans to be made later by the railroad or contractor as may be agreed upon.

If a single bridge must be obtained in the shortest possible time, it is probable that the best way to proceed is to invite proposals per pound, as above described, and while waiting for bids, to prepare plans sufficiently full for ordering the stock, these plans to be turned over to the contractor when the award is made, the material ordered by him and the shop plans and patterns made while the stock is being rolled. These methods require that a competent engineer be employed by the railroad to prepare the plans. He may be a regular employee or an outside party temporarily engaged as consulting engineer.

If course B is followed, the contractor generally works up the details subject to the approval of the railway officials. The opinion of the engineer quoted above states the objection to this course from the contractor's point of view. His position will be appreciated by all engineers who have had competitive plans submitted to them for comparison and recommendation. All such know how unsatisfactory the task is; how much more agreeable it is to make a complete design from the start than to patch up and alter something imperfectly worked out and perhaps badly conceived. Why, then, should bidders be asked to take half-worked-out schemes and complete them?

It may be claimed that this course consumes less time than A. This is true so far as placing the contract is concerned, but the proper objective is the completion of the bridge, and this can be reached quicker by course A than by course B. Other things being equal, the deciding feature is ordering the stock from the mill; and by far the quickest time can be made between the decision of the railroad to build and the placing of mill orders if the railroad makes scale plans of the work. If the contractor must work out plans before he can order his stock, they must be finished up, sent to the railroad and be examined and criticised and perhaps sent back and forth several times before they are safe to be used for listing material.

It seems that course B has but little to recommend it. Economy in the drafting room of the railroad is about all that can be claimed in its favor, and in this feature it is surpassed by C, which can be modified so as to be entirely satisfactory.

As written above, course C consists of furnishing "a full specification only, leaving the bidder to submit a design with his bid." The assumed advantages of this course are its apparent economy to the railway and the benefit of competitive designs from a number of bridge builders. If we modify the clause so as to read "a full specification only" and ask for bids by the pound and require no accompanying design, it will be wholly satisfactory. Asking bidders to submit plans with their tenders leads to practical difficulties of several kinds. On this point the engineer previously quoted says:

> I beg to call your attention to the prevailing practice of railway companies requiring to have strain sheets and designs submitted with bids. The demoralizing influences of this practice of requiring bridge companies to make designs on speculation does not seem to be sufficiently appreciated by railway engineers, they believing the bridge companies do this work gratuitously and at no expense to the railway company. However,a moment's reflection will prove the fallacy of this assumption. Each bridge company employs a number of engineers, a large portion of whose time is taken up in making strain sheets and estimates to accompany bids, a small portion of which only develop into contracts, the work being either let to other companies or is not let at all at the time. Suppose five bridge companies are invited to bid a lump sum on a piece of work and are required to submit strain sheets, etc., with their bids, in which case five men are all doing the same work, or, in other words, the same piece of work is done five times and four men's work and energies are wasted. All this superfluous work has to be paid for by the bridge companies, and increases the expense of their engineering departments, and will therefore be charged to the cost of the work. Every well-regulated bridge company includes the cost of this work in their estimates of cost, charging a higher price for lump sum jobs for which strain sheets and designs have to be submitted with the bid than for jobs on which a pound price only is required, and which puts the bridge company practically to no expense in making a bid.
>
> What the writer in his capacity as head of the engineering department of a bridge company mostly objects to is the demoralizing influence this practice of making designs on speculation has on his subordinates, whose duty it is to make strain sheets and designs. It is certainly discouraging to an engineer who is conscientious and takes pride in his work to know that over three-fourths of his work is thrown away, and less than one-fourth only is actually going to be constructed. It has a tendency to make these men careless and superficial, as it can hardly be expected that a man will take the same interest in a speculative and problematical design as in a design for an actual piece of work, more particularly as he is not allowed enough of time to do this kind of work thoroughly. He will, therefore, rush the work without giving it that careful consideration which he would give to an actual piece of work. The writer has had many times occasion to revise a design which was submitted with a bid and accepted by the railway company, but which did not meet his own idea of good practice.

This is from the standpoint of a contractor, but all must admit the force of the argument. As may be seen above, nearly half of the railroads responding to our inquiries use this objectionable method of obtaining bids, but it will be noticed that the mileage of these roads averages considerably less than half that of the other two groups.

As to the two assumed advantages for this course, economy in the railroad drafting room will be served quite as well if the bidders do not submit plans as if they do; and the benefit of competitive designs is largely fallacious. A prominent bridge specialist writes us in his response: "I am well aware that the marvelous development of American bridge building has been largely due in the past to the method of competitive designs from contractors, but that stage of evolution has now worked out its full mission and established the design and manufacture of bridges on sound scientific principles."

A railway should have some uniformity in the type of its bridges, and certainly competition in design will not conduce to this result; neither will it enhance excellence of detail; and extreme economy of material is no longer desired. It would seem that obtaining competitive plans from bidders should be discouraged by the association, unless it be in extraordinary cases of suspension, cantilever, or arch bridges, which are not within the scope of this report. Unless a railway leaves the whole matter with the contractor (which is unwise), a competent and experienced bridge engineer should be employed to check the design and superintend the inspection. If this is done, the single design furnished by the successful bidder after the award of the contract will be under as full control by the railroad as in the case when sketch designs are submitted with all the bids.

2. The Best Way to Select the Proper Builder.—The advantages of competition are so well recognized that no arguments need to be presented in its support. As to whether competition should be obtained by advertising or by selecting a few suitable bidders, the advantages, for railroad work, are all on the side of the latter method.

An engineer can serve his employers in no better way than in selecting a proper list of bidders for each class of work. If desirable, he can encourage small local concerns by giving them a chance to bid on small work, and he can omit them from the list on difficult work. If acquainted with the condition of the shops of different builders, he can judge if they are fitted for special classes of work and can turn it out in a reasonable time, and can make up his list of bidders accordingly.

A fair price can be obtained ordinarily by getting tenders from not over six bidders. Only those who would be acceptable as contractors should be asked to bid, and then the work should be let to the lowest bidders without further canvass.

A. Shall Bids be a Lump Sum for Each Job or by the Pound?—The great majority of the responses to our inquiries on the subject favor letting bridge work by the pound. This method satisfies the business principle that the seller should be paid for exactly what he furnishes. It relieves the estimator from much responsibility when working up the weight of a bridge for the purpose of making a bid, and thereby reduces the cost of this operation. It allows changes to be made in a design without hardship to anyone, and it is the only proper basis for bids when a specification only is furnished, while it is also applicable to the case when full plans are furnished.

On the other hand, a lump sum bid allows the buyer to know exactly what a given job will cost, and obviates disputes, which sometimes occur when a pound price is used, as to the final and complete weight when the bills are rendered. When the work is varied, like a draw-bridge, it is undoubtedly the best method of fixing a price. It involves no hardship to the bidder when the railway furnishes full plans, but is not applicable to those cases where a specification only is furnished. In short, it is a business question to be decided largely by the convenience of the purchaser, governed by the limitation of the course pursued in obtaining bids. The shipping weights of all parts of a bridge should be closely checked with the plans by the engineer in any case to detect underweight if the contract is by the lump, and to guard against excess weight if by the pound.

B. Shall Bids Be Obtained for Each Structure as Wanted, or Shall Contracts Be Made for Whatever May be Wanted During a Season?—If a season's requirements can be anticipated with sufficient certainty so that reasonable descriptions can be furnished to bidders, it is good business policy to make a contract cover the whole, for the reason that a large tonnage of work is very attractive to bridge companies and will call out lower prices than if cut up into smaller lots at different times. Good judgment, however, is needed as to the proper time to let the work. There is an undesirable element of speculation involved unless the price per pound is made adjustable to the market price of material at the time each bridge is detailed, and if this is done the result is practically the same as letting each bridge separately. Blanket contracts do not give a railroad opportunity to patronize small local shops, which for business reasons may be advisable, and for those roads, which erect part of their work, but not all, the separation of the two classes might be awkward.

Nearly all the railways replying to our questions usually make independent contracts for each bridge or group of bridges that can be let at one time, and under ordinary circumstances this would seem to be the proper course.

C. Shall the Work be Erected by the Contractor or the Railway?—This question is one of economy largely, and will depend on the organization and custom of each road. When equipped for it and there is sufficient work to be continuous, railroad forces can erect ordinary bridges cheaper than can be done by contractors. If work is intermittent, it will be expensive for railroad men to do it, for the reason that unprofitable work will be done in an attempt to keep the gang together between jobs.

Repair work, however extensive, should ordinarily be done by the railroad, and single girder bridges can generally be put in much cheaper by the resident forces than by men from a distance; with larger structures the case will differ on different roads. Of the 86 roads reporting to our circular, 57 state that they contract for the whole or part of their work erected, though 59 of the 86 erect at least the smaller bridges, and experience shows that when properly controlled and managed erection work can be done by contractors' forces with safety and with no undue delay to traffic. On the other hand, with proper organization and equipment, it is economical and generally satisfactory to all parties to do the work with railway forces.

SPECIFICATIONS FOR ROLLED STEEL.

On this subject your Committee has done an unusual amount of work, but has been unable to agree on a complete recommendation to the association. It is thought best to present a progress report, only stating the points on which there is substantial agreement, as well as the points on which there is a difference of opinion, with the understanding that the report is subject to probably revision after further discussion.

The points on which there is no serious disagreement are the following. It will be seen that they cover nearly complete specifications, with the exception of the grade of steel to be provided for, which is the subject of the discussion further on:

Process of Manufacture.—1. Steel shall be made by the open-hearth process.

Sample for Chemical Analysis.—2. In order to determine if the material conforms to the chemical limitations prescribed below, analysis shall be made of drillings taken from a small test ingot. When required by the inspector, check analyses shall be made of drillings from the finished product.

Chemical Requirements.—Rivet steel: Sulphur and phosphorus each not over 0.04%. Steel for other uses: Sulphur not over 0.05%. Phosphorus in basic steel, not over 0.04%, and in acid steel not over 0.08%.

*Physical Requirements.—4. Rivet steel: Tensile strength between 48,000 and 56,000 lbs., minimum yield point 26,000, minimum elongation 28%, bending test 180° flat without fracture, whether hot or cold. (See 9.)

Fractures.—5. All fractures shall be silky. A dull or crystalline fracture will be considered a failure of test, and a retest required. (See 19.)

Yield Point.—6. For the purpose of this specification, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gage of the testing machine.

Modification in Elongation for Thin and Thick Material.—7. For each increase of ¼-in. in thickness above ⅝-in. a deduction of 1% shall be allowed from the specified elongation, and for each decrease of 1-16-in. in thickness below 5-16-in. a deduction of 2½% shall be allowed from the specification.

Pin Steel.—8. In steel for pins the elongation required shall be 5% less than that specified, as determined on a test specimen cut from the finished rolled or forged bar from which pins are to be turned, the center of which specimen shall be 1 in. from the surface of the bar.

Nicked Test.—9. Rivet steel, when nicked and bent 180° around a bar, equal in diameter to the rivet rod, shall show a gradual break and a fine silky fracture. A sudden crystalline fracture will be considered a failure of test and a retest required. (See 19.)

10. For material other than rivet stock, more than 1 in. thick, bending tests may be made on specimens from the same melts of steel, but of less thickness. In such cases, the thickness of the bending test specimen shall not be less than 1 in. and may be planed or turned to this thickness.

Special Tests for Steel.—11. Steel shall also be subjected to the following test: (A) A 15-16-in. hole punched with center 1⅞ ins. from edge of sheared plate must stand drifting, without cracking the metal, until diameter of hole becomes 1¼ ins.

(B) Angles ¾-in. and less in thickness shall open flat, and all angles ½-in. and less in thickness shall bend shut, cold, under blow of a hammer, without sign of fracture.

Test Specimen for Tensile Tests.—12. The standard test specimen of 8-in. gage length shall be used to determine physical properties.

13. For other material the test specimen may be the same as for sheared plates, or it may be planed or turned parallel throughout its entire length, and in all cases, where possible, two opposite sides of the test specimen shall be the rolled surfaces. Rivet rounds and small rolled bars shall be tested of full size as rolled.

Test Specimens for Bending Test.—14. The test specimens for bending tests may be the same as for tensile tests, except as called for in paragraph No. 11. They shall preferably be 1½ ins. wide. Rivet rounds and small rolled bars to be tested full size as rolled.

15. The bending test may be made by pressure or by blows.

Number of Tests.—16. At least one tensile and one bending test shall be made for each "variety" of material into which a melt of steel is rolled under these specifications. Each of the following shall constitute a "variety": (1) Angles and Z-bars; (2) I-beams and channels; (3) universal plates; (4) sheared plates; (5) bars and rounds. Steel differing in thickness more than 25% from that tested shall require separate tests.

Failure of Tests.—17. If the ultimate tensile strength or yield point of any one test is 1,000 or more lbs. per sq. in. outside of the limits of these specifications, the lot of steel from which such test was taken shall be rejected without further testing, unless there is manifest flaw in the test specimen.

Retests.—18. If the ultimate tensile strength or yield point of any one test is below or above the prescribed limits of these specifications, by less than 1,000 lbs. per sq. in., two other tests may be made from the same lot of steel represented by such test. If these two last tests are within the limits of the specification the lot of steel will be accepted, otherwise it will be rejected.

*For physical requirements for other grades than rivet steel, see end of specifications.

10. A retest may also be made if the elongation or character of fracture of the tensile test specimen or the bending test is not in accordance with the requirements. In case of the failure of the retest, the lot of steel will be rejected.

Annealed Test Specimen.—20. Material which is to be used without annealing or further treatment shall be tested for tensile strength in the condition in which it comes from the rolls. For material which is to be annealed or otherwise treated before use, a full-sized section of tensile test specimen length shall be similarly treated before cutting the tensile test specimen therefrom.

Finish.—21. Finished material must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

Marking.—22. Every piece of steel shall be stamped with the name of the manufacturer or mill at which it is made, and the melt number and year; also the class of steel. Steel for pins and forgings shall be stamped on the end. Rivet lacing bars and small pieces for pin plates and stiffeners may be shipped in bundles, securely wired together, with the stamps on a metal tag attached.

Each piece of steel furnished under these specifications, except rivet rods and other small rolled bars) shall, before shipment, have branded cold upon it, by the manufacturer, this mark: AR in letters 2 ins. high, by which the manufacturer shall denote that the material so branded has been tested by him in full accordance with the requirement of these specifications, and has successfully withstood all of the tests herein provided for, and is of such quality as is hereby required. In case any piece of steel, after having been so branded, is condemned, for any cause whatsoever, then the brand shall be defaced by a ring stamp.

Duties of Inspector.—24. The inspector representing the purchaser shall be afforded all necessary facilities by the manufacturer to satisfy him that the material is being furnished and furnished in accordance with the requirements of the specifications. It shall be his duty to see that the system of tracing the steel from the melt to the finished product is adequate and reliable. He shall witness all tension tests and keep a personal record of the same, and shall, so far as practicable, satisfy himself that all tests are carried out in a bona fide manner. In cases of failure of tensile or bending tests he shall require satisfactory evidence that the material condemned thereby is not, through negligence or for other reasons, shipped on contracts governed by these specifications.

Rolling Orders.—25. The manufacturer shall furnish the inspector, daily, if required, a correct list of all steel rolled, on orders subject to his inspection, from every melt, as rolled, indicating on this list from what pieces tests have been or will be prepared. The inspector shall satisfy himself that sufficient tests have been provided for, and after the tests have been made, he shall notify the manufacturer what material has been successfully tested and what, if any, has failed upon tests.

Certified Shipping Bills.—26. The manufacturer shall also furnish the inspector duplicate copies of the shipping bills, or detailed lists, giving melt numbers of the material loaded for shipment on orders subject to his inspection, and after the inspector has checked these with his records of tests and accepted material, he shall sign both copies and return one copy to the manufacturer and shall send the other copy to the railroad company he represents. If these shipping bills do not check with the inspector's records of tests and accepted material, he shall not sign them, and the shipment shall not go forward until the difference is rectified.

27. No material shall be paid for by the railroad company until the bill of shipment is checked and approved by the inspector.

Surface Inspection.—28. The inspector shall have the right to make a surface inspection of any and all material under these specifications, and, when he so elects, the necessary facilities shall be afforded to him by the manufacturer. Whether the inspector makes a surface inspection of the material at the mill or not, no material having any injurious flaws will knowingly be allowed to become a part of any bridge or other structure, and in case of the discovery of any defective material shipped from the mills it will be condemned at bridge site, and will not be paid for, and it will have to be replaced by the manufacturer without additional expense to the railroad company for material, workmanship or other charges.

Variation in Weight.—29. The variation in cross-section or weight of each piece of steel of more than 2½% from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates:

30. Plates 12½ lbs. per sq. ft. or heavier, when ordered to weight, shall not vary more than 2½% above or below the theoretical weight.

31. Plates under 12½ lbs. per sq. ft., when ordered to weight, shall not vary more than the following:

32. Up to 75 ins. wide, 2½% above or below the theoretical weight.

33. For 75 ins. and over, 5% above or below the theoretical weight.

34. For all plates ordered to gage, there will be permitted an excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

Table for Allowances for Overweight for Rectangular Plates When Ordered to Gage.

Thickness of plate.	Width of plate. Up to 75 ins.	75 to 100 ins.	Over 100 ins.
Inch.	Per cent.	Per cent.	Per cent.
¼	10	14	18
5/16	8	12	16
⅜	7	10	13
7/16	6	8	10
½	5	7	9
9/16	4½	6½	8½
⅝	4	6	8
⅝	3½	5	6½

Plates Under ¼-in. Thickness.

Thickness of plate.	Width of plate. Up to 50 ins.	50 ins. and above.
Inch.	Per cent.	Per cent.
⅛ up to 5/32	10	15
5/32 " " 3/16	8½	12½
3/16 " " ¼	7	10

35. The weight of 1 cu. in. of rooled steel is assumed to be 0.2833-lb. Plate ¼-in. and over in thickness.

The points on which there is a difference of opinion among the committee are:

*Physical Requirements.—(A) The range of ultimate strength and the factors depending upon it.

*See paragraph 4 of Specifications.

(B) As to whether the requirements for yield point and elongation shall be fixed limits or ratios of the ultimate strength.

(C) As to prescribing a minimum reduction of area.

A summary of the arguments advanced is here attempted with the hope that the members of the association will discuss the matter fully so that succeeding committees on this subject may have the advantage of the information so obtained.

(A) On the important subject of range of ultimate strength for framing materials two radically different schemes have been put forward, viz: (1) A single grade to be called structural steel with ultimate strength between 55,000 and 65,000 lbs., one member preferring 57,000 to 66,000 lbs.

(2) Two grades, soft steel and medium steel, the former to be between 51,000 and 59,000 and the latter between 61,000 and 69,000.

The advocates of the single-grade scheme claim that that the range proposed covers the most desirable class of steel for ordinary structures, built by common shop methods; that it is safe to use without reaming and planing, if so desired, but is improved by reaming and planing to the same extent that harder metal is; and that if the two-grade scheme is adopted with a zone of difference between, the harder grade will necessitate reaming and planing under all circumstances and the softer grade will be unnecessarily low for any purpose; while the most desirable steel (i. e., 60,000 lbs. ult.), which is the average of the single-grade scheme and presumably the most desirable, will be shunned as much as possible by manufacturers on account of its being barred out of either grade. In other words, if the proposed two-grade scheme is adopted and manufacturers conform their practice to it that it will be difficult to obtain the grade of steel which they consider most desirable.

The grade of steel recommended at the last meeting of the European Railway Congress for the class of work here considered has a mean ultimate strength of about 57,000 lbs. per in.

For very large structures, where the dead load is a controlling factor in the design, a special grade of material is necessary, which cannot be provided for in a uniform specification, as it might require not only a difference in ultimate strength, but also in various other properties.

On the other hand, the advocates of the two-grade scheme contend that it is difficult to get material as hard as is desirable to use with reaming and planing unless a zone of difference is introduced, which unavoidably carries the soft grade into quite low steel.

They state that there is no reason from the user's point of view for the two grades merging into each other as now obtains in most specifications. That when so merging together the manufacturers endeavor to reduce their melts to a point where the ultimate strength will be as near as possible on the division line between the two grades, with the result that the product is neither especially soft nor especially strong. That the manufacturers in endeavoring to make this "common ground" steel cover both grades force inspectors to continually test material a little too hard for soft steel or a little too soft for medium steel requirements, and that if two distinct grades with a zone of difference between is established by the association it will tend to induce manufacturers to develop two classes and will do a great deal towards eliminating the trouble that now confronts engineers and inspectors in obtaining the grade of steel required, and believing that steel of 68,000 or 70,000 lbs. ultimate strength may be safely used when reamed, they are unwilling to join in recommending 65,000 lbs. as the maximum upper limit.

On this question the committee stands four in favor of the single-grade and five in favor of the two-grade scheme.

(B) On the question of fixed or variable limits for yield point and elongation the committee is divided. It is rational to make both of these factors ratios of the ultimate. The object in adopting fixed limits is to facilitate checking inspection reports, but it would seem that with properly prepared tables the labor involved by using ratios would not be more than the advantage gained would warrant. One-half the ultimate is a very common requirement for yield point, but 55% is desired by some, and is no hardship to manufacturers.

If a fixed minimum is specified for elongation it must be a figure that is reasonable for the upper limit of the grade and will be practically no guide at all near the lower limit. A table prepared on a sliding scale for each 2,500 lbs. variation of ultimate strength would be very compact and sufficiently precise for practical purposes.

(C) As to the reduction of area: This requirement is not generally included in recent specifications. It is undoubtedly a measure of the ductility of the metal, but shows this property only after the elastic limit has been long passed and, as expressed by one engineer, simply shows what the metal does in its last gasp. The majority of the committee are in favor of omitting it.

J. P. Snow, B. & M. R. R.; B. Douglas, Mich. Cen. R. R.; J. E. Greiner, B. & O. R. R.; J. R. Worcester, Con. Engr.; T. L. Condron, Con. Engr.; R. Modjeski, Con. Engr.; Onward Bates, Con. Engr.; C. L. Crandall, Cornell Univ.; Wm. Michel, Hock. Vall. Ry.

Records, Reports and Accounts.

Many railways are using more blanks and requiring more reports and records than are necessary. It is reported that a certain prominent railway, after a careful analysis of the different blanks used in the different departments, reduced the number of blanks from 1,500 to 500. This great reduction not only involved a large decrease in the necessary expenses for clerk hire and for stationery, but it also relieved the different officers from the unnecessary labor of examining and considering a mass of details from which no adequate results were obtained.

In determining the necessity of a report or a record or an account only one principle should be followed, viz.: What good result is obtained?

Our investigation so far reveals the fact that the railway bridge departments are weak on this matter of records. There does not seem to be any uniformity in the systems in use, and it is apparent that many roads are keeping very incomplete records of their bridges. Most of the inquiries sent out by the committee were answered with the statement that no particular system was used.

It is recommended that bridges be numbered by location in miles and hundreds from one terminal running toward another. If additional structures are then added, it will not be necessary to use half numbers or letters of the alphabet. Bridges on branches should be numbered after the same system, using an initial to designate each branch road.

The Superintendent of Bridges should send to the Engineer of Maintenance-of-Way daily reports of the work done and material used, giving cost of the labor and number of the structure on which work was done, these reports being checked against the records of authorized repairs. From these daily reports, after checking with time books, should be figured, monthly, the cost of all work, showing material used, pieces and dimensions. This should be entered in a monthly cost book, from which, by combining the various months' work, the annual statements can be made, in a more condensed form, for the permanent record. With this record, the cost of any work to date could be quickly furnished.

Plans on tracing cloth of superstructure and masonry, with foundation plan of each bridge, should be filed together in atlas form, detachable so prints could be had at any time. Plans of superstructure should be separate from masonry and foundation, and of same size, 20 × 36 ins. Scale for general plans, ¼-in. to 1 ft. For detail plans, ½-in. to 1 ft. Topography for 300 ft. in all directions should be shown in one corner of masonry and foundation plan on a scale of 100 ft. to the inch, with a profile extending 300 ft. or more each side of the bridge.

Drains may be shown several together on one sheet, with distance from terminal noted, and cost. All permanent openings 10 ft. wide and more to be considered bridges, and numbered 1-2-3 accordingly, from one end of each division or branch line. The smaller openings to be indicated on each mile by letters, 2-b-3, as 40a, 43b, so that if any are closed up or new ones added it will affect renumbering only on that particular mile.

All plans should be filed according to the card index system. This has been found very satisfactory, and it enables one to find plans in very short order, or very frequently to get the information required without resorting to the drawings at all.

The subject of the proper filing of engineer's records may be divided into two parts: (1) A place in which records may be filed; (2) the ready locating of them after they are filed. The latter involves an adequate system of indexing, the best form for this purpose being undoubtedly the card index method. Each index ought to indicate clearly the shelf or compartment in which each class of plans or papers is filed.

The adequate storage for engineer's records involves ample room, light, freedom from dust, security and proper cases, arranged to permit of any classification outlined by the card index. Where records are kept in buildings not fireproof, they should, of course, be stored, if valuable, in vaults. Where buildings are fireproof, and the amount of plans and papers is large, it is better to store them outside of vaults, securing more light and room, and equipping the room so that it will be a vault in itself. The New York Central R. R. has a room of this character in the new Grand Central Station, New York, all woodwork being eliminated, the floors concrete, doors fireproof to shut out fire from other parts of the building, and the room equipped entirely in non-combustible fittings.

Rolled plans are most conveniently and securely filed in map tubes or drawers, one drawer given to each rolled plan or set of plans in one roll. This method, however, while entirely free from dust, is expensive from the point of cost where there are large masses of plans to be filed.

Large drawers properly subdivided by partitions may be conveniently utilized for this class of papers, or they may be stored directly on open shelving, the shelving spaced to suit the diameter of the rolls. Where very large masses of old plans are to be accommodated, compartments or bins with drop fronts may be provided. This method is utilized in the room of the New York Central R. R. mentioned above. Plans for current use in fireproof rooms

can be conveniently disposed of in bases covered with table tops or drawing boards.

Flat plans or tracings are best handled in shallow drawers, the rear of drawer being fitted with a hood to protect the rear edges of plans. A good file or drawer for this purpose is one having a drop front, which, when pulled down, reveals the entire contents of the drawer at front. Plats mounted on cardboard or in thin books can be kept on shelves, spaced in height the thickness of the book, having a vertical index at the right or left of opening on a narrow strip. The whole case to be protected by curtains or doors. These shelves need not take up over ¼-in. vertically. The front of shelf should be stepped back 2 ins. under the book or plat, so it may be handled readily. Leases are more conveniently kept in document files than in any other form of device.

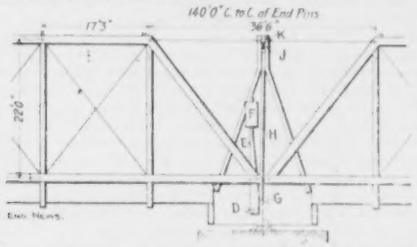


Fig. 1. Non-Continuous Swing Bridge on the Lake Shore & Michigan Southern Ry.

For the construction of case work for this purpose metal has some distinctive advantages, requiring less space and being non-inflammable. The large amount of engineers' records lost by fire gives especial importance to the last point. The New York Central R. R. room is equipped in metal work of this kind, as are the filing rooms of the Pittsburg & Lake Erie R. R. in the new central office at Pittsburg. The Engineering News of Jan. 2, 1902, illustrates the equipment of the last named room very clearly, and an explanation of the card index system at that room is given in the same article by Mr. R. P. Forsberg. The explanation and illustrations are exceptionally clear and complete.

F. E. Bissell, L., S. & M. S. Ry.; E. F. Wendt, P. & L. E. Ry.; L. F. Goodale, Burlington; Roland Woodward, J. & S. W. Ry.; E. K. Woodward, Wabash R. R.; G. H. Webster, Can. Pac. Ry.; H. Rohwer, Mo. Pac. Ry.; T. J. Frazier, B. & O. R. R.; George Houliston, Penna. R. R.; F. E. Nicholson, N. & S. Ry.

THE NON-CONTINUOUS SWING BRIDGE; TWO EXISTING STRUCTURES OF THIS TYPE.

In our issue of Feb. 27, we described a type of swing bridge in which the spans on either side of the tower are practically independent, and the lifting of the ends to allow the bridge to swing is accomplished by raising the eyebars running from the tower to the hips of the trusses, and so tilting the trusses slightly on the bottom chord end-pins at the tower. Since then we have received the information given below concerning two bridges of a similar construction built about ten years ago.

Mr. J. W. Schaub, M. Am. Soc. C. E., writes that a non-continuous swing bridge was designed and built under his direction for the Lake Shore & Michigan Southern Ry. in 1889, when he was Engineer of the Detroit Bridge & Iron Works. Mr. A. L. Colby, at present Engineer of these works (now the Detroit plant of the American Bridge Co.), has kindly furnished us with blue prints of the structure. Mr. Carl Binder was at that time Bridge Engineer for the railway company.

The bridge is 140-ft. span, single track, and was built to carry the road over the Huron River, just east of Sandusky, O. As the bridge would rarely be opened, and might be replaced later with a fixed span, it was desired to make the machinery as simple as possible, and also to so design the structure that the two parts could be separated and used as independent spans. A diagram of the truss and its central tower is shown in Fig. 1, the tower consisting of two A-frames seated on the turntable and having the upper part of the legs made vertical to serve as guides for the sliding portions. Between these guides was a transverse I-beam carrying the pins for the looped ends of the bars running to the hips of the trusses.

The mechanism and method of operation are shown in Fig. 2, the bridge being, it may be noted, operated by hand. The capstan-head, A, in the floor of the bridge forms the head of a 3-in. vertical shaft carrying a worm, B, the worm being 8 ins. diameter and 7 ins. long, with a pitch of

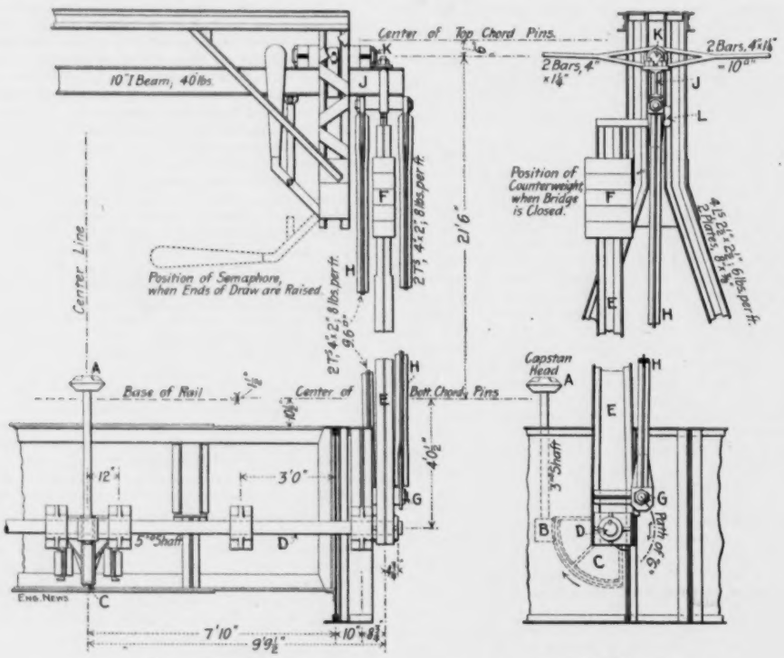


FIG. 2. DETAILS OF END LIFT MECHANISM OF NON-CONTINUOUS SWING BRIDGE, LAKE SHORE & MICHIGAN SOUTHERN RY.

2½ ins. This gears with the segment of a worm wheel, C, 21 ins. radius, 5 ins. wide on the face, and 2½ ins. pitch. The segment is keyed to the 5-in. transverse operating shaft, D, to the ends of which are keyed the counterweight arms, E, on the ends of which are the adjustable blocks, F. Near the heel of each arm is a pin, G, carrying two operating bars, H, each composed of two T-bars, 4 × 2 ins. These bars are attached by pin bearings to the transverse 10-in. I-beam, J, on which are mounted the bearings for the pins, K, carrying the looped ends of bars 1¼ × 4 ins., running to the hip joints of the trusses, as already noted. The mechanism is shown in normal position, with the bridge closed. To raise the ends, preparatory to swinging the bridge, the shaft and worm, B, are operated by capstan bars, causing the arm, E, to revolve to the right and the pin, G, to describe the path indicated by the dotted line. This pulls down the beam, J, and the looped ends of the bars, thus tilting the two truss spans on the end pins of the lower chord at the tower. To lower the ends when the bridge is closed, the worm is revolved in the opposite direction, the ends of the trusses

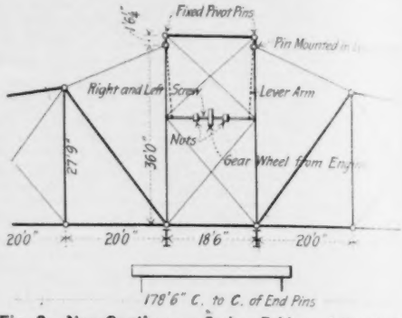


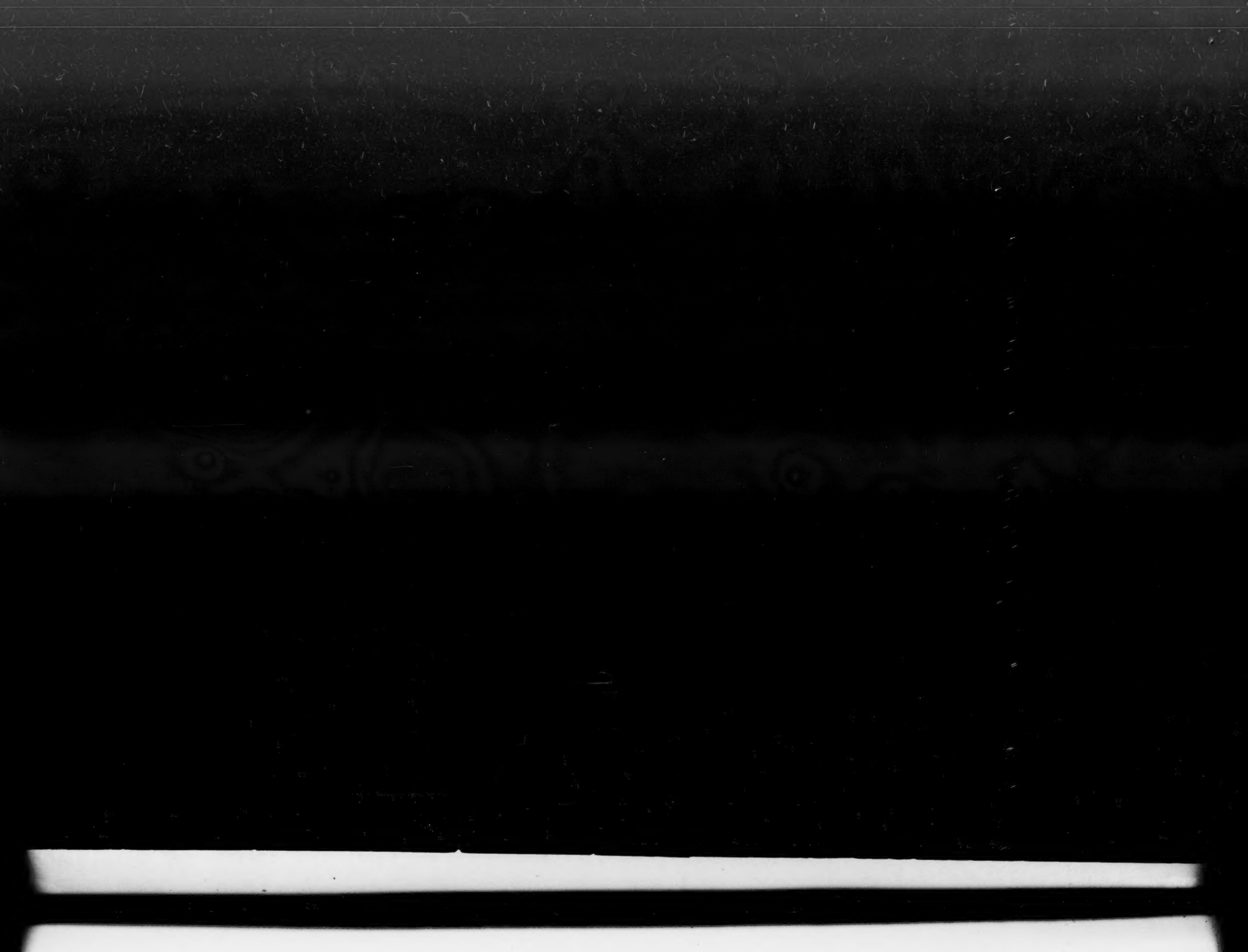
Fig. 3. Non-Continuous Swing Bridge of the N. Y., P. & B. R. R. at Mystic, Conn.

dropping by their own weight, and so keeping a tension on the bars.

On the end of the counterweight arm is a hooked bar, L, engaging with the stirrup of the beam, J, and so preventing the ends from dropping below the required travel. A curved semaphore arm is pivoted to the tower and operated by a connecting rod from the beam, J, so that as the beam falls in raising the ends, the semaphore is thrown across the track as a "stop" signal.

At the time when the bridge was designed it was recognized that the friction on the pin, K, and on the end pins, or hinges of the trusses, would be very high, as noted by a correspondent in our issue of March 6; and also that to provide a bearing of such size as to bring the friction within ordinary limits for journal bearings would involve a very unwieldy attachment. While this resistance would make it hard to operate the bridge, yet, in view of the fact that the bridge was to be operated but rarely, and that it was desirable to avoid all mechanism on the spans themselves, the system was, nevertheless, adopted. We are informed that the bridge was moved nine years ago to the crossing of the Grand Rapids Branch over Grand River, near Grand Rapids, Mich., and is there yet. The end-lift device is considered perfectly satisfactory for a light swing bridge.

A letter from Mr. J. A. MacNicol, M. Am. Soc. C. E., of 39 Cortlandt St., New York, calls our attention to a non-continuous swing bridge at Mystic, Conn., built in 1892 for the New York, Providence & Boston Ry., now part of the New York, New Haven & Hartford R. R. It was built by the Boston Bridge Works from a design prepared by Mr. MacNicol.

This bridge is of 178 ft. 6 ins. span, and was designed for heavy loading, as required by the specifications adopted by Mr. E. P. Dawley, then Chief Engineer of the railroad. Fig. 3 illustrates the method of operating the bridge. The top chord members running from the inner hips to the tower connect to pins mounted in long vertical lever-arms, the latter being pivoted at their upper ends, on pins attached to the tower. The lower ends of the levers are attached to horizontal bars in the plane of the trusses, which at their inner ends carry nuts sliding in guides. A right-and-left screw engages the two nuts on each side of the tower, and is rotated by gearing from the engine-house. Evidently, when the screws are turned in the proper direction the bars will pull on the long ends of the vertical lever-arms, and thus will draw inward the top chord eye-bars; this raises the ends of the two arms of the bridge.

Mr. MacNicol states that the bridge is now, after ten years, still in successful operation. He also states that a highway bridge of quite long span has since been built by the Boston Bridge Works, of similar design to the one described, which design Mr. MacNicol has patented.